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*Cytisus aeolicus* Guss. - Vulcano, Eolie Islands, Italy



**Soil microbial diversity has an impact on plant diversity and safeguard.** Bacterial and Archaeal communities play a key role in biogeochemical cycles of C, N, S and P and are main players in ecosystem functioning. Nevertheless, only generic information is available on diversity of prokaryotes in water and soil ecosystems and microbial diversity is not on the biodiversity conservation agenda. One reason for this oversight is due to the opinion that microbes are generally resistant to physico-chemical fluctuations and resilient to perturbations, moreover their functions are considered redundant and not menaced by loss of biodiversity. Assessing microbial diversity, however, is a challenge due to microscopic size and to the fact that only 1% of the actual microbial diversity is represented as cultured organisms while the characteristics and functions of the remaining 99% are largely unknown. Recently, molecular techniques have contributed to open the black box of microbial diversity in natural ecosystems and helped linking taxonomic and functional diversity. Among the ecosystem services provided by prokaryotes nitrogen fixation is the most exclusive and crucial for life on earth. Symbiotic nitrogen fixing bacteria fix atmospheric nitrogen in the plant root nodules thus providing nitrogen nutrition to cultivated and spontaneous legumes. Spontaneous legume shrubs such as *Anagyris foetida*, *Genista* spp., *Calicotome* spp., *Spartium junceum*, *Astragalus* spp., play an important role for the conservation of soils, especially during the primary and secondary succession. Soil is a key natural resource that is threatened by desertification and pollution and its protection is essential to human health, to return land to agriculture and to increase the pool of soil carbon in order to mitigate climate change. In semi-arid Mediterranean ecosystems shrubby legumes have great potential for rehabilitation of degraded/anthropogenic soils as they establish mutualistic symbiosis not only with N-fixing rhizobia but also with mycorrhizal fungi that contribute to P uptake and plant fitness. Both symbiosis are highly specific and soil disturbance can prevent the formation of beneficial plant-microbes symbiosis. Most of the rhizobia isolated from Sicilian native and endemic shrub legumes, Genisteae in particular, are slow-growing rhizobia phylogenetically affiliated to the genus *Bradyrhizobium*. A strict specificity was evidenced between *Cytisus aeolicus* and its root symbionts that differ by effectiveness and competition ability for nodule occupancy. *C. aeolicus* is an endangered plant species strictly endemic of Aeolian Archipelago (South Tyrrhenian Sea, Italy). Due to differences from other species and sharp taxonomic isolation it is considered a relic species. The reintroduction of selected specific microbial symbionts may thus improve plant survival and help spreading rare legumes. Once identified, these beneficial symbiosis can be exploited for rehabilitation of arid, low productive and human-impacted soils of the Mediterranean area. To preserve and exploit the diversity of rhizobia a collection from wild Mediterranean legumes is maintained at the laboratory of Microbial Ecology & Environmental Microbiology of the Dept. STEBICEF at the University of Palermo: a little effort to preserve, understand and protect the huge diversity of the unseen majority.



Cover photo by A. Troia. Up: Root nodules of *Anagyris foetida* (photo T. La Mantia)



Colonization Etna lavas by endemic species *Astragalus siculus* and *Genista aetnensis* (photo T. La Mantia)

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# Checklist of aphyllorphoroid fungi (Basidiomycota) of the Ekenäs Archipelago National Park, Southern Finland

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## ABSTRACT

This is the first checklist of aphyllorphoroid fungi (Basidiomycota) of the Ekenäs Archipelago National Park on the Finnish south coast. The focus is on wood-dwelling polypores and corticioids. The material was collected in the years 1989, 1990, 2010 and 2012, respectively, during one or a few days each year. The field work was carried out on the two largest islands: Älgö and Jussarö. The number of species detected was 150, which is 20% of all the Finnish polypores and corticioids. Eight of the species are nationally or regionally threatened.

## KEY WORDS

aphyllorphorales; corticioids; fungal diversity; polypores; species richness.

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## INTRODUCTION

For the polypores and corticioids the term aphyllorphorales is used solely for pragmatic reasons. Both of the groups are highly diverse and polyphyletic (Hibbett et al., 2014). In this study we concentrated on species which are saprobes, parasites or mycorrhizal, but for instance the clavarioid taxa and soil dwelling hydnaceous fungi (e.g., *Bankera* Coker & Beers ex Pouzar, *Hydnellum* P. Karst., *Hydnum* Linnaeus) are excluded.

In the checklist of Kotiranta et al. (2009) 756 corticioids and polypores are reported from Finland, and 489 of them occur on the southwestern coast of Finland where our study islands are situated. After this Finnish checklist numerous papers have been published with new records of aphyllorphoroid fungi (e.g., Kunttu et al., 2010; 2012; Kotiranta & Shiryayev, 2013; Spirin et al., 2013a). There is only one earlier large scale biogeographical study of

aphyllorphorales from the Finnish southern archipelago (Kunttu et al., 2015).

The Ekenäs Archipelago National Park was founded in 1989. One part of the national park was former Jussarö Strict Nature Reserve which was established in 1956. The national park contains a few hundreds of islands or skerries, and the land area is 844 hectares and sea area 4577 hectares (Nordström & Tainio, 2012). It is also a part of the large Natura 2000 conservation area, dominated by sea and archipelago landscapes (Nordström & Tainio, 2012).

The national park is situated in the Gulf of Finland (approx. 59° N, 23° E) in the hemiboreal vegetation zone (Ahti et al., 1968) in section Ib (see e.g., Kotiranta et al., 2009, p. 7 or Rassi et al., 2010, p. 27). It belongs to the Uusimaa biogeographical province (Hansen & Knudsen, 1997).

The national park extends from larger forested islands near the mainland out to rugged skerries and



open seascapes of the Gulf of Finland. The park is divided into inner, middle and outer archipelago zones (Häyren, 1948). The larger islands inhabit also old-growth forests suitable for pretentious wood-decayers. Small islands have been saved from intense forestry but household use for building, fodder for domestic animals and collecting of firewood have occurred. Small islands are mainly poor, rocky Scots pine (*Pinus sylvestris* Linnaeus) dominated, and in general the forests are mainly barren *Cladina*-, *Calluna*-, *Empetrum-Vaccinium*- and *Myrtillus*-site-type heath forests with only some patches of herb-rich forests (Bonn & Routasuo, 1997; Nordström & Tainio, 2012).

As a whole, the national park contains high biodiversity with rare and threatened species and habitat types, like 13 Natura 2000-habitat types according to the European Union's Habitat Directive, and 61 threatened or near-threatened species (Nordström & Tainio, 2012; Metsähallitus, 2014).

## MATERIAL AND METHODS

This study was carried out on the two largest islands of the national park: Älgö (698 hectares) and Jussarö (134 hectares). Inventories were concentrated in the southern parts of Älgö (48 hectares) and the western parts of Jussarö (66 hectares). Heikki Kotiranta (HK) surveyed and collected material during the autumns 1989 and 1990, Panu Kunttu (PK) 2010 and Jorma Pennanen (JP) 2012. Altogether these inventories contained eight days of field work.

The authors PK and JP used the inventory methods according to Junninen (2009), which is widely used in polypore inventories in the state owned forests. The focus was on rare, red-listed and old-growth forest indicators. HK sampled extensively both polypores and corticioids, but PK and JP concentrated more on polypores and collected corticioids only occasionally and selectively (large, hydroid species). PK and JP made most of their inventories in the forest stands with the highest volume of dead wood, and generally these were Norway spruce, *Picea abies* (Linnaeus) H. Karsten, dominated forests.

The island of Älgö is located on the northern boundary of the national park (Fig. 1). It is the largest island of the park with some small lakes, and

is mostly covered with coniferous forests intermixed with deciduous trees, like birches (*Betula* spp. Linnaeus) and aspen (*Populus tremula* Linnaeus) (Fig. 2). On the stony shores and other wet places black alder (*Alnus glutinosa* (Linnaeus) Gaertner) is common. Selectively loggings in spruce forests were made 40 years ago but part of these forests have been restored recently (Nordström & Tainio, 2012).

The island of Jussarö is located on the eastern boundary of the national park (Fig. 1), and is the second largest in the park. Such forested inlands are unusual in the outer archipelago zone. It is divided into two parts: the western part is dominated by old-growth forests with up 150 years old spruces (Fig. 3), and it has been untouched for decades, and the eastern side is strongly affected by mining, which was practised over hundred years until 1960's (Nordström & Tainio, 2012).

The specimens were identified by the authors themselves. Voucher specimens are deposited in the herbaria of Universities of Turku (TUR), Helsinki (H) and/or private collections of the authors HK and JP. The nomenclature follows mainly Kotiranta et al. (2009), but of the genus *Hyphodontia* sensu lato Hjortstam & Ryvarden (2009). Some recent combinations are according to Miettinen & Larsson (2011), Miettinen et al. (2012) and Spirin et al. (2013b). The Finnish national red-listing evaluation of the IUCN red list categories is according to Kotiranta et al. (2010).

## RESULTS

A total of 150 species are listed in Table 1 in alphabetic order regardless of their systematic position. This is ca. 20% of all known species of these species groups in Finland and ca. 30% of species found from the hemiboreal oak zone (section 1b). The list comprises 66 polypores, 83 corticioids and one wood inhabiting hydneous species (*Mucronella bresadolae*). It is a matter of taste whether one species belongs to polypores or corticioids. For instance *Schizopora paradoxa* and the poroid *Trechispora* species are here included in corticioids. The most species-rich genera are *Phellinus* (9 species), *Peniophora* (7 species), *Postia* (7 species), *Skeletocutis* (5 species) and *Trechispora* (5 species).



Following red-listed species were found: *Amylocorticium subincarnatum* (VU), *Skeletocutis stellae* (VU), *Aporpium canescens* (NT, RT), *Fomitopsis rosea* (NT, RT), *Onnia tomentosa* (NT), *Phlebia centrifuga* (NT, RT), *Sidera lenis* (NT, RT) and *Skeletocutis odora* (NT, RT). All these species grow almost solely in old-growth forests, and nowadays their survival is dependent on protected areas.

The list of species contains three virgin forest indicators (VFI) and 11 old-growth forest indicators (OFI) of pine and spruce dominated forests (Table 1). According to the classification of old-growth forest indicators by Kotiranta & Niemelä (1996) these two forest areas reach 13 points for spruce dominated forests and 10 points for pine dominated forests.

## DISCUSSION

The number of species (150) found in the Ekenäs Archipelago National Park is an expected number of species in Southern Finland if compared to the consumed time and studied area (ca. 10% of the whole land area of the national park). It is well known that fungi do not fruit every year (Straatsma et al., 2001) and species occupying narrow ecological niches may have been overlooked (Juutilainen et al., 2011). So, many more species could be found with more intensive field work, because the forests of the national park offer wide range of tree species, diversity of habitats and high volume of dead wood. Especially the corticioids are under-represented in this material and quite common species, like *Amphinema byssoides* (Pers.: Fr.) J. Eriksson, are lacking from our list. For example, from the near-situated Archipelago Sea National Park 303 polypores and corticioids were listed (Kunttu et al., 2015).

We studied quite little barren and rocky Scots pine dominated forest habitats and therefore some specialist species living in kelo trees have not been found in our study. Kelos are dead and old age trunks of Scots pine, and their surface is grey, hard and decorticated. Scots pine can become kelo tree mainly on dry and barren forest habitats (Leikola, 1969; Niemelä et al., 2002). It is known that kelo trees sustain specific fungal diversity (Niemelä et al., 2002). Also a comprehensive inventory of black

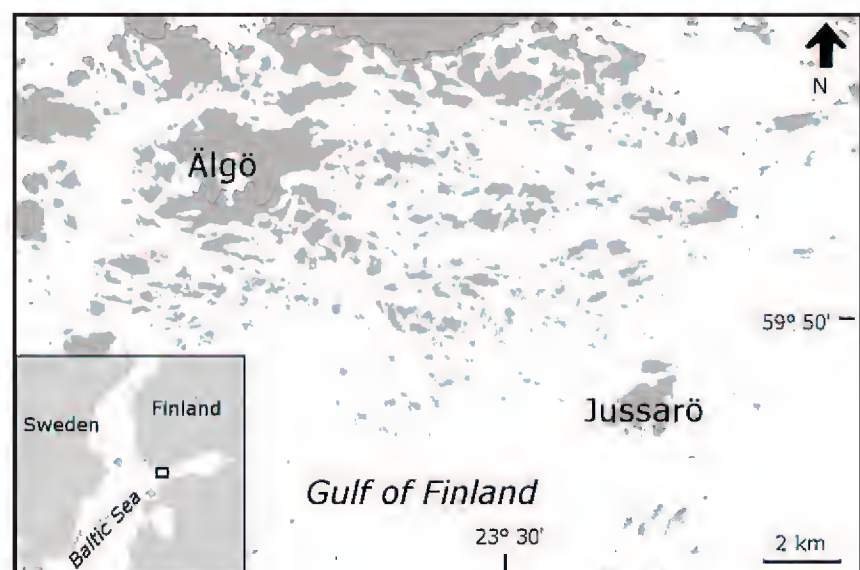


Figure 1. Location of the study islands: Ekenäs Archipelago National Park, Southern Finland.



Figure 2. Mixed forest near the shore on the island of Älgö.



Figure 3. Old-growth spruce forest on the island of Jussarö.



Species and authors	Status
<i>Alutaceodontia alutacea</i> (Fr.) Hjortstam et Ryvarde, 2002	
<i>Amylocorticiu subincarnatu</i> (Peck) Pouzar, 1959	VU
<i>Amylostereu chailletii</i> (Pers.) Boidin, 1958	
<i>Amylostereu laevigatu</i> (Fr.) Boidin, 1958	
<i>Antrodia serialis</i> (Fr.) Donk, 1966	
<i>Antrodia sinuosa</i> (Fr.) P. Karsten, 1881	
<i>Antrodia xantha</i> (Fr. : Fr.) Ryvarde, 1973	
<i>Antrodiella pallescens</i> (Pilát) Niemelä et Miettinen, 2006	
<i>Antrodiella serpula</i> (P. Karst.) Spirin et Niemelä, 2006	
<i>Aphanobasidium pseudotsugae</i> (Burt) Boidin et Gilles, 1989	
<i>Aporpium canescens</i> (P. Karst.) Bondartsev et Singer, 1944	NT, RT
<i>Asterodon ferruginosus</i> Patouillard, 1894	OFI
<i>Athelia acrospora</i> Jülich, 1972	
<i>Athelia arachnoidea</i> (Berk.) Jülich, 1972	
<i>Athelia epiphylla</i> Persoon, 1822	
<i>Basidioradulum radula</i> (Fr.) Nobles, 1967	
<i>Bjerkandera adusta</i> (Willd.: Fr.) P. Karsten, 1879	
<i>Botryobasidium botryosum</i> (Berk. et M.A. Curtis) J. Eriksson, 1958	
<i>Botryobasidium subcoronatu</i> (Höhn. et Litsch.) Donk, 1931	
<i>Bulbillomyces farinosus</i> (Bres.) Jülich, 1974	
<i>Byssomerulius corium</i> (Fr.) Parmasto, 1967	
<i>Ceraceomyces eludens</i> K.H. Larsson, 1998	
<i>Ceriporiopsis balaenae</i> Niemelä, 1985	
<i>Cerrena unicolor</i> (Bull.: Fr.) Murrill, 1903	
<i>Chondrostereu purpureu</i> (Pers.: Fr.) Pouzar, 1959	
<i>Cinereomyces lindbladii</i> (Berk.) Jülich, 1982	
<i>Climacocystis borealis</i> (Fr.) Kotlaba et Pouzar, 1958	
<i>Conferticiu ochraceu</i> (Fr.: Fr.) Hallenberg, 1980	
<i>Coniophora arida</i> (Fr.) P. Karsten, 1868	
<i>Coniophora olivacea</i> (Pers.: Fr.) P. Karsten, 1879	
<i>Coniophora puteana</i> (Schumach.: Fr.) P. Karsten, 1868	
<i>Corticium roseu</i> Persoon, 1794	
<i>Cylindrobasidium evolvens</i> (Fr.) Jülich, 1974	
<i>Cytidia salicina</i> (Fr.) Burt, 1924	

<i>Daedaleopsis confragosa</i> (Bolton: Fr.) J. Schröter, 1888	
<i>Datronia mollis</i> (Sommerf.) Donk, 1966	
<i>Eichleriella deglubens</i> (Berk. et Broome) D.A. Reid, 1970	
<i>Exidiopsis calcea</i> (Pers.: Fr.) K. Wells, 1962	
<i>Fomes fomentarius</i> (L.: Fr.) Fr., 1849	
<i>Fomitopsis pinicola</i> (Sw.: Fr.) P. Karsten, 1881	
<i>Fomitopsis rosea</i> (Alb. et Schwein.: Fr.) P. Karsten, 1881	NT,RT, OFI
<i>Galzinia incrustans</i> (Höhn. et Litsch.) Parmasto, 1965	
<i>Ganoderma applanatu</i> (Pers.) G.F. Patouillard, 1887	
<i>Ganoderma lucidu</i> (M.A. Curtis: Fr.) P. Karsten, 1881	
<i>Globuliciu hiemale</i> (Laurila) Hjortstam, 1973	
<i>Gloeocystidiellu porosum</i> (Berk. et M.A. Curtis) Donk, 1931	
<i>Gloeophyllum odoratu</i> (Wulfen: Fr.) Imazeki, 1943	
<i>Gloeophyllum sepiarium</i> (Wulfen: Fr.) P. Karsten, 1882	
<i>Gloeoporus dichrous</i> (Fr.: Fr.) Bresadola, 1912	
<i>Heterobasidion parviporum</i> Niemelä et Korhonen, 1998	
<i>Hymenochaete fuliginosa</i> (Pers.) Bresadola, 1846	
<i>Hymenochaete tabacina</i> (Sowerby) Lévillé, 1846	
<i>Hyphodontia alutaria</i> (Burt) J. Eriksson, 1958	
<i>Hyphodontia arguta</i> (Fr.) J. Eriksson, 1958	
<i>Hyphodontia pallidula</i> (Bres.) J. Eriksson, 1958	
<i>Hypochniciu albostramineu</i> (Bres.) Hallenberg, 1985	
<i>Hypochniciu bombycinu</i> (Sommerf. et Fr.) J. Eriksson, 1958	
<i>Hypochniciu multiforme</i> (Berk. et Broome) Hjortstam, 1998	
<i>Inonotus obliquus</i> (Pers.: Fr.) Pilát, 1942	
<i>Inonotus radiatus</i> (Sowerby: Fr.) P. Karsten, 1881	
<i>Ischnoderma benzoinu</i> (Wahlenb.: Fr.) P. Karsten, 1879	
<i>Junghuhnia nitida</i> (Pers.: Fr.) Ryvarde, 1972	
<i>Laxitextu bicolor</i> (Pers.: Fr.) Lentz, 1956	
<i>Leptoporus mollis</i> (Pers.: Fr.) Quélet, 1886	OFI
<i>Leptosporomyces galzinii</i> (Bourdot) Jülich, 1972	
<i>Leucogyrophana romellii</i> (Fr.) Ginns, 1978	
<i>Lobuliciu occultu</i> K.H. Larsson et Hjortstam, 1982	
<i>Megalocystidium leucoxanthu</i> (Bres.) Boidin, 1978	



<i>Meruliopsis taxicola</i> (Pers.: Fr.) Bondartsev, 1959	OFI
<i>Mucronella bresadolae</i> (Quél.) Corner, 1970	
<i>Oligoporus rennyi</i> (Berk. et Broome) Donk, 1971	
<i>Oligoporus sericeomollis</i> (Romell) Bondartsev, 1983	OFI
<i>Onnia tomentosa</i> (Fr.) P. Karsten, 1889	NT
<i>Peniophora cinerea</i> (Pers.: Fr.) Cooke, 1879	
<i>Peniophora incarnata</i> (Pers.: Fr.) P. Karsten, 1889	
<i>Peniophora limitata</i> (Chaillet ex Fr.) Cooke, 1879	
<i>Peniophora nuda</i> (Fr.) Bresadola, 1950	
<i>Peniophora pithya</i> (Pers.) J. Eriksson, 1950	
<i>Peniophora polygonia</i> (Pers.: Fr.) Bourdot et Galzin, 1928	
<i>Peniophora violaceolivida</i> (Sommerf.) Masee, 1890	
<i>Peniophorella praetermissa</i> (P. Karst.) K.H. Larsson, 2007	
<i>Peniophorella pubera</i> (Fr.) P. Karsten, 1889	
<i>Phaeolus schweinitzii</i> (Fr.) Patouillard, 1900	OFI
<i>Phanerochaete sanguinea</i> (Fr.) Pouzar, 1973	
<i>Phanerochaete velutina</i> (DC.: Fr.) P. Karsten, 1968	
<i>Phellinus alni</i> (Bondartsev) Parmasto, 1976	
<i>Phellinus cinereus</i> (Niemelä) Parmasto, 1976	
<i>Phellinus conchatus</i> (Pers.: Fr.) Quélet, 1886	
<i>Phellinus ferrugineofuscus</i> (P. Karst.) Bourdot, 1932	OFI
<i>Phellinus igniarius</i> (L.: Fr.) Quélet, 1886	
<i>Phellinus laevigatus</i> (P. Karst.) Bourdot et Galzin, 1928	
<i>Phellinus pini</i> (Brot.: Fr.) A. Ames, 1913	OFI
<i>Phellinus punctatus</i> (P. Karst.) Pilát, 1942	
<i>Phellinus tremulae</i> (Bondartsev) Bondartsev et Borisov, 1953	
<i>Phlebia centrifuga</i> P. Karsten, 1881	NT, RT, VFI
<i>Phlebia radiata</i> Fr., 1821	
<i>Phlebia tremellosa</i> (Schr.: Fr.) Nakasone, 1984	
<i>Phlebiella</i> cf. <i>subnites</i> (Bourdot et Galzin) K.H. Larsson et Hjortstam, 1987	
<i>Phlebiella sulphurea</i> (Pers.: Fr.) Ginns et Lefebvre, 1993	
<i>Phlebiella tulasnelloidea</i> (Höhn. et Litsch.) Ginns et Lefebvre, 1993	
<i>Piloderma fallax</i> (Liberta) Stalpers, 1984	
<i>Piptoporus betulinus</i> (Bull.: Fr.) P. Karsten, 1881	
<i>Polyporus brumalis</i> (Pers.: Fr.) Fr., 1818	
<i>Postia alni</i> Niemelä et Vampola, 2001	
<i>Postia caesia</i> (Schr.: Fr.) P. Karsten, 1881	

<i>Postia fragilis</i> (Fr.) Jülich, 1982	
<i>Postia leucomallella</i> (Murrill) Jülich, 1982	OFI
<i>Postia ptychogaster</i> (F. Ludw.) Vesterholt, 1996	
<i>Postia stiptica</i> (Pers.: Fr.) Jülich, 1982	
<i>Postia tephroleuca</i> (Fr.) Jülich, 1982	
<i>Pseudotomentella mucidula</i> (P. Karst.) Svrček, 1958	
<i>Pycnoporellus fulgens</i> (Fr.) Donk, 1971	OFI
<i>Pycnoporus cinnabarinus</i> (Jacq.: Fr.) P. Karsten, 1881	
<i>Radulomyces confluens</i> (Fr.: Fr.) M.P. Christensen, 1960	
<i>Resinicium bicolor</i> (Alb. et Schwein.: Fr.) Parmasto, 1968	
<i>Resinicium furfuraceum</i> (Bres.) Parmasto, 1968	
<i>Rigidoporus populinus</i> (Schumach.: Fr.) Pouzar, 1966	
<i>Schizopora paradoxa</i> (Schr.: Fr.) Donk, 1967	
<i>Scytinostroma odoratum</i> (Fr.) Donk, 1956	
<i>Scytinostroma portentosum</i> (Berk. et M.A. Curtis) Donk, 1956	
<i>Serpula himantioides</i> (Fr.: Fr.) P. Karsten, 1885	
<i>Sidera lenis</i> (P. Karst.) Miettinen, 2011	NT, RT, VFI
<i>Sistotrema sernanderi</i> (Litsch.) Donk, 1956	
<i>Skeletocutis amorpha</i> (Fr.) Kotlaba et Pouzar, 1958	
<i>Skeletocutis biguttulata</i> (Romell) Niemelä, 1998	
<i>Skeletocutis carneogrisea</i> A. David, 1982	
<i>Skeletocutis odora</i> (Sacc.) Ginns, 1984	NT, RT, OFI
<i>Skeletocutis stellae</i> (Pilát) Jean Keller, 1979	VU, VFI
<i>Spongiporus undosus</i> (Peck) A. David, 1980	
<i>Stereum hirsutum</i> (Willd.: Fr.) Gray, 1800	
<i>Stereum rugosum</i> Pers.: Fr., 1794	
<i>Stereum sanguinolentum</i> (Alb. et Schwein.: Fr.) Fr., 1838	
<i>Subulicystidium longisporum</i> (Pat.) Parmasto, 1968	
<i>Trametes hirsuta</i> (Wulfen: Fr.) Pilát, 1939	
<i>Trametes ochracea</i> (Pers.) Gilbertson et Ryvarden, 1987	
<i>Trametes pubescens</i> (Schumach.: Fr.) Pilát, 1939	
<i>Trametes velutina</i> (Fr.) G. Cunningham, 1965	

Table 1/1. Aphyllorphoroid fungi of the Ekenäs Archipelago National Park. Red list status in Finland: VU = Vulnerable, NT = Near Threatened, RT = Regionally Threatened. Indicator species: VFI = Virgin Forest Indicator, OFI = Old-growth Forest Indicator (continued).



Species and authors	Status
<i>Trechispora cohaerens</i> (Schw.) Jülich et Stalpers, 1980	
<i>Trechispora farinacea</i> (Pers.: Fr.) Liberta, 1966	
<i>Trechispora hymenocystis</i> (Berk. et Broome) K.H. Larsson, 1994	
<i>Trechispora mollusca</i> (Pers.: Fr.) Liberta, 1974	
<i>Trechispora subsphaerospora</i> (Litsch.) Liberta, 1973	
<i>Trichaptum abietinum</i> (Pers.: Fr.) Ryvarden, 1972	
<i>Trichaptum fuscoviolaceum</i> (J.C. Schmidt: Fr.) Kreisel, 1972	
<i>Tubulicrinis accedens</i> (Bourdot et Galzin) Donk, 1956	
<i>Tylospora fibrillosa</i> (Burt) Donk, 1960	
<i>Vesiculomyces citrinus</i> (Pers.) E. Hagström, 1977	
<i>Vuilleminia comedens</i> (Nees: Fr.) Maire, 1902	
<i>Xylodon asperus</i> (Fr.) Hjortstam et Ryvarden, 2009	
<i>Xylodon brevisetus</i> (P. Karst.) Hjortstam et Ryvarden, 2009	

Table 1/2. Aphylloroid fungi of the Ekenäs Archipelago National Park. Red list status in Finland: VU = Vulnerable, NT = Near Threatened, RT = Regionally Threatened. Indicator species: VFI = Virgin Forest Indicator, OFI = Old-growth Forest Indicator.

alders could reveal more aphylloroid species, therefore that black alder hosts many rare or little collected species in Finland (Kunttu et al., 2011; 2012; 2014).

Based on the indicator points of Jussarö and Älgö, these are valuable in the view of nature conservation. Particularly on Jussarö, the spruce dominated old-growth forest is very valuable in the sense of forest biodiversity. It has been estimated to be one of the most representative old-growth forests on the south coast of Finland (Nordström & Tainio, 2012). Remote location and early protection in 1956 have saved forests of western Jussarö. Also in general, isolated location have saved some archipelago areas from large-scale intensive forestry and this explains why certain forests in the archipelago have a high degree of naturalness. Precisely 11% of land area of the Ekenäs Archipelago National Park is boreal natural forest according to Natura 2000-habitat type definition (Metsähallitus, 2014).

Relatively many aphylloroid fungi found here have a preference, or are even depending on

old-growth forests. Many of these are today common only in protected areas in northern or eastern Finland (Renvall, 1995; Lindgren, 2001; Sippola et al., 2005). It is obvious that the distribution of these species has earlier covered almost the whole Finland, but as a result of forceful forestry with large clear-cuttings these species have viable populations nowadays only in the large protected areas in northern and eastern Finland. Small old-growth forest fragments are maybe not large enough to preserve the most pretentious virgin forest species. This is especially alarming since the dispersal ability of many fungal species with specialised resources and habitat requirements is weak; it affects the occurrences of these species in fragmented landscapes (Norros et al., 2012) and therefore colonization of species can be slow after disturbance (Kouki et al., 2011). The Finnish southern archipelago is far away from the present occurrence sites of these wood-inhabiting fungi with strict habitat requirements related to natural characteristics of forests and thus the returning of these species can be a long process.

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## ***Pontoscolex corethrurus* (Müller, 1857) (Oligochaeta Glossoscolecidae) in forest transformation system in Bungku Village, Jambi, Indonesia**

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### **ABSTRACT**

*Pontoscolex corethrurus* (Müller, 1857) (Oligochaeta Glossoscolecidae) is a widely distributed exotic earthworm. We showed that *P. corethrurus* completely dominated the secondary forest and agricultural plantations in Bungku Village, Jambi Province, Sumatra, Indonesia. Bungku Village in Jambi consists of the forest undergoing transformation into oil palm plantation, rubber plantations, and rubber jungle. Purposive random sampling with hand-sorting method was conducted to extract *P. corethrurus*. We found that all of 940 recovered earthworms were *P. corethrurus*. Their density was not significantly different in the four systems. Our result showed that *P. corethrurus* abundance was significantly influenced by soil physical factor, mineral content, and texture. We propose that anthropogenic practice in Bungku Village caused the condition which does not support the native earthworms. *Pontoscolex corethrurus* which have better tolerance than the native earthworms are favored by anthropogenic practice.

### **KEY WORDS**

earthworm; exotic; oil palm; rubber; soil.

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### **INTRODUCTION**

*Pontoscolex corethrurus* (Müller, 1857) (Oligochaeta Glossoscolecidae) is a widely distributed exotic earthworm (Brown et al., 2006; Gonzalez et al., 2006; Hendrix et al., 2006). This endogeic earthworm is originally native in South America and is the commonest earthworm in Brazil (Hendrix & Bohlen, 2002). Nowadays, it is quite dispersed up to South Africa and Asia Pacific regions as alien species (Plisko, 2001; Blakemore, 2010). Its dispersal is probably related to the introduction of rubber plant, *Hevea brasiliensis* (Willd. ex A. Juss.) Müll. Arg.), from Brazil (Murdiyarso et al., 2002;

Nath & Chaudhuri, 2010) or pine seedling (*Pinus* sp.) (Plisko, 2001). Frequently, it becomes invasive competing with the native earthworms or colonizing the disturbed habitat where the native earthworms are reduced (Gonzalez et al., 2006).

Anthropogenic transformation of forest results in unfavorable and reduced resources for native earthworms (Hendrix et al., 2006; Marichal et al., 2010). *Pontoscolex corethrurus* density increases with the increase in the age of disturbed habitat while the density of native earthworms decreases (Nath & Chaudhuri, 2010). The native earthworms tend to disappear and *P. corethrurus* fills the niche (Gonzalez et al., 2006; Marichal et al., 2010).



Although direct competition with native earthworms is common, the extirpation of natives is not easily demonstrated (Hendrix et al., 2006). On the other hand, Hendrix et al. (2006) stated that exotic earthworms invade ecosystem even in the absence of obvious human disturbance. Therefore, it requires more study to conclude that the anthropogenic influence is necessary for *P. corethrurus* to successfully invade the area.

Indonesia experienced almost half million hectare net loss of forest area in 2000-2010 (FAO, 2010). Central Sumatra had annual deforestation rate of 3.2–5.9% (Achard et al., 2002) and Jambi is undergoing a rapid primary forest transformation into agricultural system (Murdiyarso & Wasrin, 1995). Bungku Village in Jambi consists of the forest undergoing transformation into oil palm plantation, rubber plantation, and rubber jungle. Here, we showed that *P. corethrurus* completely dominated the secondary forest and agricultural plantations in Bungku Village, Jambi Province, Sumatra, Indonesia. Moreover, we also analyzed the soil parameters affecting their abundance.

## MATERIAL AND METHODS

### Study sites

Sampling was conducted on November 2012 in wet season in Bungku Village, Batanghari Regency, Jambi (1°15'–2°20' south latitude - 120°30'–104°30' east longitude) (Fig. 1). This area had average annual temperature of 25.5 °C and cumulative

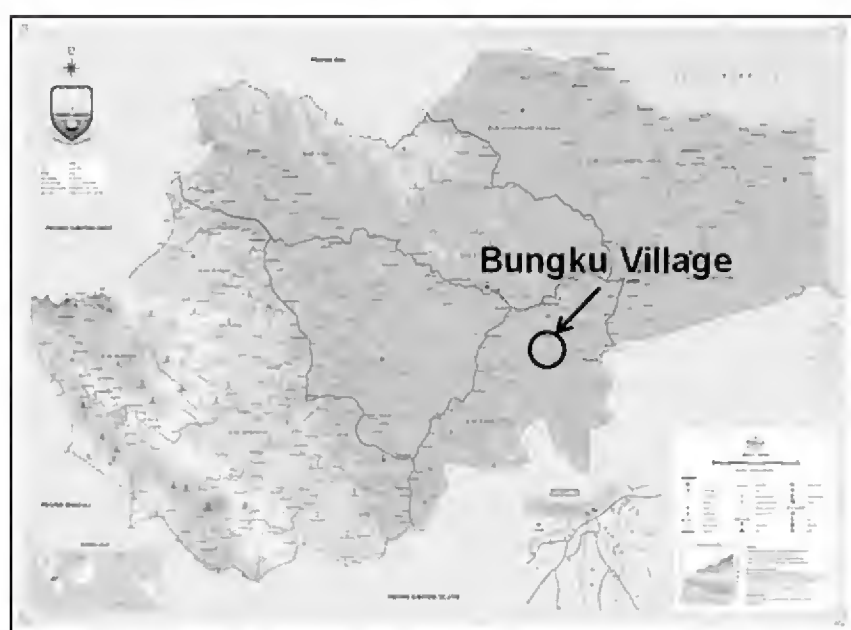


Fig. 1. Study site in Jambi Province, Indonesia.

precipitation of 2700 mm (BPPD, 2010). Sampling area comprised of 15 year-old oil palm plantation (S 01° 54' 33.8", E 103° 15' 56.3"), 11 year-old rubber plantation (S 01° 54' 39.6", E 103° 15' 59.3"), 19 year-old rubber jungle (S 01° 55' 39.9", E 103° 15' 32.0"), and secondary forest (S 01° 54' 52.1", E 103° 15' 57.3"). The coordinates were taken in the outer side of each system.

Dominant plants in oil palm plantation were oil palm, *Elais guineensis* Jacq., and grass (Gramineae). Rubber plantation consisted of only rubber, *Hevea brasiliensis*. Rubber jungle was dominated by rubber, Asian melastome, *Melastoma candidum* D. Don., grass, and billian, *Eusideroxylon zwageri* Teijsm. et Binn. Meanwhile, secondary forest was dominated by tempinis, *Sloetia elongata* Koord., medang, *Litsea firma* (Blume) Hook. f., and bamboo (Bambusoideae). Vegetation analysis using profile method revealed that the structure of old jungle rubber and secondary forest are similar (Gouyon et al., 1993).

### Pontoscolex corethrurus extraction

Purposive random sampling was conducted to extract *P. corethrurus*. Three sets of sampling sites, about 20 m apart from each other, were placed in each system. Each set consisted of 25 of 30 x 30 cm and 30 cm depth plots placed randomly 1 m apart from each other, making total of 75 plots in each system. Hand-sorting method was carried out. *Pontoscolex corethrurus* were cleansed with paper towel prior to recording the biomass and fixation in 70% ethanol. Due to insensitivity of the weight scale, we only measured the adult *P. corethrurus* biomass. Identification and description of *P. corethrurus* were conducted by following Blakemore method (2010). *Pontoscolex corethrurus* with and without clitellum were classified into adult and juvenile, respectively. Meanwhile, *P. corethrurus* without anterior part was classified into unknown stage.

*Pontoscolex corethrurus* in this study showed the following characteristics: length 60–80 mm. Width approximately 3 mm. Segments 173–230 with secondary annulations. Unpigmented with yellowish clitellum. Prostomium retracted (preserved specimen). Dorsal pore absent. Setae 8 per segment, quincunx in posterior. Nephropores difficult to see, clear from segment 10/11. Clitellum saddle shaped, 15–22,23. Male pores and female



pores difficult to see. The first spermathecal pores in 6/7. Genital markings on 19-21. Septa thick on 6/7, 7/8, 8/9. Dorsal blood vessel single. Hearts in 10 and 11 look strong. Gizzard spherical and muscular in 6. Calciferous glands three pairs, under the thick septa in 7-9. Intestine origin in 13 or 14. Nephridia holoic. Testes probably in 10. Seminal vesicles elongated in 12. Prostate absent. Spermathecae three pairs in 7-9.

### Soil parameter

Human disturbance may cause changes in soil physical and chemical properties (Guariguata & Ostertag, 2001) viz. temperature, pH, water, mineral content, and texture, which are directly related to the *P. corethrurus* abundance (Edwards, 2004). Soil parameters observed were soil physical factors (temperature, pH, water content), mineral content (C organic, P, Ca, Mg, K, Na), and texture (sand, silt, clay).

Soil physical factors were assessed in each plot. Soil temperature was measured using soil thermometer. Meanwhile, soil pH and water contents were measured using soil pH and humidity tester.

Soil mineral content and texture were assessed following compositing method. Soils from each set of sampling site were sampled, making total of 12 soil samples for 4 systems (3 samples for each system). Five hundred grams of soil was air dried prior to analyzing its C organic, P, Ca, Mg, K, Na contents, and texture. The soils were analyzed for organic content and texture following Walkley-Black and Pipette method, respectively. Meanwhile, soil Ca, Mg, K, and Na contents were analyzed using neutral 1 M ammonium acetate (NH<sub>4</sub>OAc) method. Afterward, soil phosphorus was analyzed using solution of HCl 25% (Sarkar & Halder, 2005). Soil analysis was conducted in Laboratory of Department of Soil Science and Land Resource, Faculty of Agriculture, Bogor Agricultural University.

### Statistical analysis

Data analysis was conducted using R 2.11.0 software (Ihaka & Gentleman, 1996; R Development Core Team, 2010). Kruskal-Wallis test in 'agricolae' package (Mendiburu, 2010) was used to assess *P. corethrurus* density, adult biomass, and

soil parameters in all systems. Soil factors influencing *P. corethrurus* abundance was analyzed by constructing generalized linear model as the abundance followed Poisson distribution (Zuur et al., 2009). *Pontoscolex corethrurus* abundance as response, soil factors as predictors. Soil factors were transformed logarithmic naturally to meet the normality assumption. Outliers were removed from analysis. Collinearity among soil factors was assessed using Variance Inflation Factors, and the value of 3.00 was set as threshold. The model was simplified using drop1. The final model used was: *P. corethrurus* abundance ~ pH + water content + C organic + Na + salt. Homogeneity of variance was assessed on model residual vs. fitted value and independence of soil factors was assessed on model residual vs. soil factors plot. No clear pattern on those plots indicated that the model met homogeneity of variance and independence assumption.

## RESULTS

### *Domination, density, and adult biomass of P. corethrurus in four land systems*

A common effect of anthropogenic disturbance into agricultural system is domination of exotic earthworm like in Tripura, India, where *P. corethrurus* successfully dominated rubber plantation with >70% frequency (Chaudhuri et al., 2008; Chaudhuri & Nath, 2011). We also found *P. corethrurus* in Bungku Village. All of 940 recovered earthworms there were *P. corethrurus*. Previous study by Bignell et al. (2000) found only two earthworm species in neighboring 15 years old monoculture rubber plantation and one species in secondary forest in Pasir Mayang, Jambi. However, they found five species in jungle rubber of Pancuran Gading, Jambi, which contained rubber trees and secondary forest regrowth with liana. Unfortunately, they did not mention the earthworm species. They concluded that earthworms had low diversity in Jambi except in Sengon (Paraserianthes) plantation and jungle rubber. In comparison, the other study conducted by Darmawan et al. in undisturbed forest in West Java recovered more than six earthworm species including *P. corethrurus* (unpublished data).



*Pontoscolex corethrurus* density was not significantly different in the four systems (Table 1). All of our results were lower than previous study in Tripura, India, which found a *P. corethrurus* density of 78-88 ind/m<sup>2</sup> (Chaudhuri et al., 2008; Chaudhuri & Nath, 2011).

The adult biomass  $\pm$  SD of *P. corethrurus* in oil palm plantation, rubber plantation, rubber jungle, and secondary forest were  $7.56 \pm 6.25a$ ,  $4.74 \pm 3.49b$ ,  $7.56 \pm 6.23a$ , and  $5.45 \pm 4.15b$  g/m<sup>2</sup> respectively (p-value < 0.01). The values with the same letter are not different.

#### ***Soil parameters in four land systems and their influence on P. corethrurus abundance***

Oil palm and rubber plantation had high value of soil phosphorus and potassium as the consequences of being fertilized with NPK (nitrogen, phosphate, potassium) by the land owner (Table 2). Conceptually, tree plantations may affect earthworm community structure through alteration of soil physical and chemical properties (Gonzalez et al., 1996; Sarlo, 2006; Nadeem et al., 2007). However, rubber plantation and mixed forest which had similar soil properties consisted of different earthworm community structures in Tripura, India (Chaudhuri & Nath, 2011). As earthworm abundance is affected by soil parameters, our result showed that *P. corethrurus* abundance was significantly influenced by soil physical factor, mineral content, and texture (Table 3).

## **DISCUSSION**

Severely disturbed habitat caused by anthropogenic practices such as deforestation or transformation into agricultural system often lead to soil inhabitation by exotic earthworm (Nath & Chaudhuri, 2010). If the disturbance is severe, it is possible that the native species be extirpated leaving only the exotic species (Gonzalez et al., 2006) as in our study. In that case, the native earthworms were reduced because of failure to adapt to the new environment, and then the niche was colonized by exotic earthworms.

Colonization of *P. corethrurus* in Bungku Village might be also associated with the plant species in the area i.e., rubber and oil palm planta-

tions, which do not support the other earthworm species (Sarlo, 2006). In addition, *P. corethrurus* has better tolerance to fill the niche left by the natives (Gonzalez et al., 2006). Most earthworms tolerate narrow range of temperature. However, *P. corethrurus* can tolerate approximately 13-27 °C of temperature (Kale & Krishnamoorthy, 1979) and even up to 29 °C in the present study. *Pontoscolex corethrurus* is characterized as having constant oxygen consumption without diurnal rhythm and tolerance for low oxygen availability (Chuang & Chen, 2008). The epidermal cells of *P. corethrurus* consist of more granules, so it can secrete more mucus to provide the protection from UV light as compared to *Amyntas gracilis* and *Metaphire posthuma* (Chuang et al., 2006; Gonzalez et al., 2008). Parthenogenesis also occurs in *P. corethrurus* and it can enhance their colonization (Hendrix & Bohlen, 2002). They are also able to enter diapause and regenerate the lost posterior segment regardless of soil moisture (Fragoso & Lozano, 1992).

Our result showed no significant difference of *P. corethrurus* density in the four systems, and this was not in agreement with previous study which mentioned that earthworm density was higher in forest than plantation (Marichal et al., 2010; Chaudhuri & Nath, 2011). Concerning the overall lower density of *P. corethrurus* than that reported in previous study, we speculate that it might be due to the higher soil pH (6.5) as *P. corethrurus* prefers lower pH (< 5.0) (Chaudhuri et al., 2008; Nath & Chaudhuri, 2010). We also found boar tracks in the secondary forest. Hence, we hypothesize that in secondary forest, predation by wild boars, *Sus scrofa* Linnaeus, 1758, caused a lower *P. corethrurus* density in Jambi, as predation can become a limiting factor for the exotic earthworms to invade new habitat (Hendrix et al., 2006). Consequently, their lower density caused lower biomass. Moreover, we only assessed the adult *P. corethrurus* biomass. For comparison, the previously mentioned *P. corethrurus* from Tripura, India, had biomass of 26–30 g/m<sup>2</sup> (Chaudhuri et al., 2008; Chaudhuri & Nath, 2011).

Our result showed that soil pH and water content were important soil physical factors. Most earthworms prefer normal soil pH (Edwards, 2004), and few of them can live in acidic soil (Ismail & Murthy, 1985). *Pontoscolex corethrurus* is an earthworm which can tolerate or even prefer acidic



System	Stage			Total
	Juvenile	Adult	Unknown	
Oil palm plantation	7.85 ± 10.30	22.22 ± 19.55	7.11 ± 9.95	37.33 ± 21.51
Rubber plantation	5.78 ± 8.04	20.44 ± 17.90	5.93 ± 8.82	32.15 ± 20.31
Rubber jungle	8.74 ± 10.38	23.56 ± 18.08	4.44 ± 7.08	36.74 ± 25.20
Secondary forest	6.67 ± 9.13	20.00 ± 13.30	6.67 ± 9.13	33.33 ± 18.63
P-value	0.24	0.64	0.41	0.48

Table 1. Kruskal-Wallis test of *Pontoscolex corethrurus* density in each system.  
The values are mean of *P. corethrurus* abundance/m<sup>2</sup> ± SD.

System	Oil palm plantation	Rubber plantation	Rubber jungle	Secondary forest	All systems
Temperature (°C)	29.76 ± 1.46 <sup>a</sup>	27.81 ± 1.06 <sup>b</sup>	26.54 ± 1.14 <sup>d</sup>	27.47 ± 0.90 <sup>c</sup>	27.90 ± 1.65
pH	6.67 ± 0.15 <sup>a</sup>	6.51 ± 0.18 <sup>b</sup>	6.44 ± 0.16 <sup>c</sup>	6.47 ± 0.23 <sup>bc</sup>	6.52 ± 0.20
Water content (%)	61.47 ± 20.53 <sup>a</sup>	46.80 ± 12.88 <sup>c</sup>	38.11 ± 8.05 <sup>d</sup>	51.88 ± 12.65 <sup>b</sup>	49.56 ± 16.51
C-organic (%)	1.91 ± 0.13 <sup>b</sup>	1.86 ± 0.17 <sup>c</sup>	1.72 ± 0.33 <sup>d</sup>	2.79 ± 0.07 <sup>a</sup>	2.07 ± 0.47
P (ppm)	97.93 ± 1.44 <sup>a</sup>	95.10 ± 3.56 <sup>b</sup>	81.9 ± 4.31 <sup>d</sup>	93.57 ± 4.00 <sup>c</sup>	92.12 ± 7.05
Ca (me/100g)	2.02 ± 0.31 <sup>a</sup>	4.80 ± 4.35 <sup>a</sup>	0.66 ± 0.16 <sup>c</sup>	1.62 ± 0.47 <sup>b</sup>	2.28 ± 2.67
Mg (me/100g)	0.61 ± 0.14 <sup>b</sup>	0.49 ± 0.15 <sup>c</sup>	0.30 ± 0.03 <sup>d</sup>	0.94 ± 0.02 <sup>a</sup>	0.58 ± 0.26
K (me/100g)	0.15 ± 0.02 <sup>b</sup>	0.16 ± 0.01 <sup>a</sup>	0.11 ± 0.01 <sup>d</sup>	0.14 ± 0.01 <sup>c</sup>	0.14 ± 0.02
Na (me/100g)	0.33 ± 0.05 <sup>b</sup>	0.33 ± 0.07 <sup>b</sup>	0.19 ± 0.02 <sup>c</sup>	0.44 ± 0.01 <sup>a</sup>	0.32 ± 0.10
Sand (%)	20.18 ± 2.25 <sup>c</sup>	23.41 ± 2.61 <sup>b</sup>	26.10 ± 4.44 <sup>a</sup>	26.77 ± 10.67 <sup>a</sup>	24.11 ± 6.54
Silt (%)	47.95 ± 3.52 <sup>a</sup>	46.22 ± 4.76 <sup>b</sup>	38.95 ± 9.14 <sup>d</sup>	41.93 ± 6.92 <sup>c</sup>	43.76 ± 7.33
Clay (%)	31.87 ± 4.19 <sup>a</sup>	30.30 ± 4.15 <sup>a</sup>	34.95 ± 8.16 <sup>a</sup>	31.30 ± 3.80 <sup>a</sup>	32.12 ± 5.63

Table 2. Kruskal-Wallis test of soil parameters in each system. Mean ± SD, values with the same letter in a row are not significantly different (p-value < 0.05).



Soil parameter	Slope	Std. Error	Z value	P-value
pH	-2.888	1.168	-2.473	0.013
Water content	0.303	0.110	2.760	0.006
C organic	0.551	0.190	2.901	0.004
Na	-0.505	0.125	-4.049	< 0.001
Sand	-0.482	0.124	-3.900	< 0.001
Null deviance: 307.16 on 289 degrees of freedom				
Residual deviance: 263.77 on 284 degrees of freedom				
AIC: 1084.20				

Table 3. Soil parameters affecting *Pontoscolex corethrurus* abundance.

soil (Nath & Chaudhuri, 2010). Hence, negative influence of soil pH in our result was in agreement with that theory. For positive influence of soil water content, it is not peculiar as water is essential to maintain *P. corethrurus* moisture.

Meanwhile, soil C organic and Na content were important soil mineral factors. As organic matter is the main source for earthworm diet (Ismail & Murthy, 1985; Edwards, 2004), it is not surprising to have higher abundance of *P. corethrurus* in soil containing higher C organic. Na showed negative influence on *P. corethrurus* abundance. Na is influenced in Na-K pump which regulates internal fluid (Barrett et al., 2005). Excess of Na causes unbalance of internal fluid.

High sand fraction was not preferred by *P. corethrurus*. Sandy soil cannot hold the water well and earthworms are susceptible to drought (Edwards, 2004). Therefore, the negative influence of sand fraction supports the positive influence of soil water content to *P. corethrurus* abundance.

In summary, we propose that anthropogenic practice in Bungku Village causes the condition which does not support the native earthworm’s survival. *Pontoscolex corethrurus* which have better tolerance than the native earthworms are favored by anthropogenic practice. Therefore, they are able to fill the niche left by natives and

completely dominating oil palm plantation, rubber plantation, rubber jungle, and secondary forest in Bungku Village. Their abundance is influenced by soil pH, water, C organic, sodium, and sand content. Sampling in larger area is needed to study about *P. corethrurus* domination in Indonesian disturbed forest.

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# Field survey of freshwater fishes in Upper Wang River, North Thailand

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## ABSTRACT

The present paper reports a fields survey of freshwater fish in Upper Wang River, at Jae Hom District, Lumpang Province, North Thailand in September 2013. We found 11 families and 16 species of freshwater fishes. *Hampala macrolepidota* Kuhl et van Hasselt, 1823 and *Mystacoleucus marginatus* (Valenciennes, 1842) (Cypriniformes Cyprinidae) are dominant in transparent and running fast stream ecosystem while *Pangio anguillaris* (Vaillant, 1902) (Cypriniformes Cobitidae) is a dominant in turbid and running slowly stream ecosystem. One species, *Channa* cf. *gachua* (Hamilton, 1822) (Perciformes Channidae), still has an unclear taxonomic status. The Thai local names and distribution data of freshwater fishes are provided.

## KEY WORDS

freshwater fishes; Wang River; Lumpang Province; Thailand.

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## INTRODUCTION

Wang River is a tributary of Chao Phraya Basin, it originates at the Phi Pan Nam Mountain Range, Wiang Pa Pao District, Chiang Rai Province, North Thailand. The river flows from north to south, from Chiang Rai Province to Lumpang Province, southward passing into the Tak Province, Northwest Thailand. The Wang River System is altogether 335 kilometers (208 miles) long. It joins the Ping River near Ban Tak District, Tak Province and The Ping River is itself a tributary of the Chao Phraya River System (Vidthayanon et al., 1997).

The Wang Basin is part of the Ping Basin and the Chao Phraya Watershed. The total land area drained by the Wang River and its tributaries is 10,792 square kilometres (4,167 square miles). The geography of upper Wang River is a plain hill and a little flat land, but the lower area is relatively flat

(The Working Group of the Office of Natural Water Resources Committee of Thailand, nd.). Upper Wang River is characterized by its own ecological features which differentiate it from the other river systems of Thailand. Although it is certainly of interest, nevertheless is poorly investigated and little is known about freshwater fishes occurring in this area. The survey project on freshwater fishes of the Upper Wang River at Jae Hom District, Lumpang Province, North Thailand (Figs. 1-3) was carried out in September 2013. We separated this area into 3 regions in accordance to the ecosystems; namely:

1. Main stream under Kio Kho Ma Dam (Fig. 2). The average width of the stream is about 15 m, average depth is less than 1 m, the bottom is a combination of sand, gravel and large rock, the stream is transparent and running fast.

2. Main stream in Ban Hui Sa Nao, Jae Hom District, Lumpang Province (Fig. 3). The average





Figures 1–3. Study area, Upper Wang River, Lumpang Province, North Thailand.

width of the stream is about 20 m, average depth is about 1 m, the bottom is a combination of clay and sandy mud, the stream is turbid and running slowly.

3. Main stream in Ban Mae Ta Lung, Jae Hom District, Lumpang Province. The average width of the stream is about 10 m, average depth is less than 1 m, the bottom is a combination of sandy mud and gravel, the stream is rather transparent (transparency is about 70 cm) and running fast.

ACRONYMS. Standard length (SL).

## RESULTS

### SYSTEMATICS

Order OSTEOGLOSSIFORMES L.S. Berg, 1940

Family NOTOPTERIDAE Bleeker, 1859

*Notopterus notopterus* (Pallas, 1769)

Bronze featherback

DISTRIBUTION. This species is known from India Sub-continent to South East Asia

THAI LOCAL NAME. Pla sa lad.

Order CYPRINIFORMES Bleeker, 1859

Family CYPRINIDAE Cuvier, 1817

*Hampala macrolepidota* Kuhl et van Hasselt, 1823

Hampala barb

DISTRIBUTION. This species (Fig. 4) is known from Chao Phraya Basin, Thailand; Mekong Basin, Indochina; Malay Peninsula and Indonesia.

REMARKS. This species is dominant in transparent and running fast streams. In Thailand, *H. macrolepidota* is a fish predominantly of clear and fast flowing streams and rivers, but sometimes can be found in reservoir and standing water (Kottelat, 2001).

THAI LOCAL NAME Pla kra soob ked.

*Mystacoleucus marginatus* (Valenciennes, 1842)

Indian river barb

DISTRIBUTION. This species (Fig. 5) is known from Myanmar to Indonesia.



REMARKS. This species is dominant in transparent and running fast streams. In Thailand, *M. marginatus* can be found in many hill streams with sand, gravel or large rocks and can be found in reservoir and large running fast rivers (Kottelat, 1998).

THAI LOCAL NAME. Pla kee yok or Pla num lung.

***Labiobarbus siamensis*** (Sauvage, 1881)  
Long finned barb

DISTRIBUTION. This species is known from Chao Phraya Basin and Bankpakong, Thailand; Mekong Basin, Indochina.

THAI LOCAL NAME. Pla sar.

Family COBITIDAE Swainson, 1838

***Acanthopsoidea gracilentus*** (Smith, 1945)  
Horseface loach

DISTRIBUTION. This species is known from Chao Phraya Basin and Maeklong Basin, Thailand; Mekong Basin, Indochina.

THAI LOCAL NAME. Pla larg kluy kae.

***Pangio anguillaris*** (Vaillant, 1902)  
Loach

DISTRIBUTION. This species is known from Chao Phraya Basin, Thailand; Mekong basins, Indochina; Malay Peninsula; Sumatra and Borneo, Indonesia.

REMARKS. This species is dominant in turbid and running slowly streams. In the nature, *P. anguillaris* lives in peat swamp, inhabits sand, mud or leaf-litter in slow running streams (Rainboth, 1996).

THAI LOCAL NAME. Pla sai thong.

Order SILURIFORMES Cuvier, 1816  
Family BAGRIDAE Bleeker, 1858

***Hemibagrus nemurus*** (Valenciennes, 1840)  
Yellow mystus

DISTRIBUTION. This species is known from Myanmar; Thailand; Indochina; Malaysia and Indonesia.

THAI LOCAL NAME. Pla kod luang.

***Mystus singaringan*** (Bleeker, 1846)  
Long fatty finned mystus

DISTRIBUTION. This species is known from Thailand; Indochina; Malay Peninsula; Sumatra, Borneo, and Java, Indonesia.

THAI LOCAL NAME. Pla ka yang bai kow.

Order BELONIFORMES L.S. Berg, 1937  
Family BELONIDAE Bonaparte, 1835

***Xenentodon cancila*** (F. Hamilton, 1822)  
Freshwater garfish

DISTRIBUTION. This species is known from India Sub-continent to Southeast Asia. Introduced in America.

THAI LOCAL NAME. Pla kra tung hav.

Order SYNBRANCHIFORMES J.S. Nelson, 1994  
Family MASTACEMBELIDAE



Figures 4, 5. Dominant species of freshwater fishes found in study area. *Hampala macrolepidota*, 141 mm SL (Fig. 4) and *Mystacoleucus marginatus*, 98 mm SL (Fig. 5).

***Mastacembelus favus*** Hora, 1924

Tire track eel

DISTRIBUTION. This species is known from Thailand to Malay Peninsula.

THAI LOCAL NAME. Pla kra ting.

Order PERCIFORMES Bleeker, 1859

Family AMBASSIDAE Klunzinger, 1870

***Parambassis siamensis*** (Fowler, 1937)

Siamese glassfish

DISTRIBUTION. This species is known from Indochina to Malay Peninsula; introduced in Singapore and Indonesia.

THAI LOCAL NAME. Pla pan ghav.

Family NANDIDAE Bleeker, 1852

***Pristolepis fasciata*** (Bleeker, 1851)

Malayan leaf-fish

DISTRIBUTION. This species is known from Myanmar to Indonesia.

THAI LOCAL NAME. Pla mor chang yab.

Family OSPHRONEMIDAE Bleeker, 1859

***Trichopsis vittata*** (Cuvier, 1831)

Croaking gourami

DISTRIBUTION. This species is known from Myanmar to Indonesia.

THAI LOCAL NAME. Pla sev kvay.

Family ELEOTRIDAE Bonaparte, 1835

***Oxyeleotris marmorata*** (Bleeker, 1852)

Marble goby

DISTRIBUTION. This species is known from Thailand to Philippines.

THAI LOCAL NAME. Pla bu sai.

Family CHANNIDAE Fowler, 1934

***Channa* cf. *gachua*** (Hamilton, 1822)

Dwarf snakehead

DISTRIBUTION. This species is known from India Sub-continent to Southeast Asia.

REMARKS. In Thailand, the taxonomic status of this taxon is still unclear, being reported from time to time as *C. gachua* or *C. limbata*.

THAI LOCAL NAME. Pla gung.

***Channa striata*** (Bloch, 1793)

Striped snakehead

DISTRIBUTION. This species is known from Pakistan, India Sub-continent to Southeast Asia and China; introduced in Europe, Africa, America, Philippines, Papua New Guinea and Korea.

THAI LOCAL NAME. Pla chon.

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# The mole crab *Hippa marmorata* (Hombron et Jacquinot, 1846) (Crustacea Anomura Hippidae): a first record from Indonesian waters

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## ABSTRACT

Specimens of *Hippa marmorata* (Hombron et Jacquinot, 1846) (Crustacea Anomura Hippidae) were collected from several coastlines of Indonesia (Sulawesi, Lombok, Tual Island, and West Papua). The specimens represent the first record of this species in Indonesia and confirm its presence in the Wallacea Line region and to its eastern fringes. Its systematic and morphological characteristics (i.e., anterior median lobe of carapace having two lobes and left antenna having two to three articles) are described. This finding provides new information on the geographical distribution of the species in Indonesian waters.

## KEY WORDS

Anomura; first record; mole crab; Hippidae; Indonesia.

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## INTRODUCTION

Mole crabs of the family Hippidae are distributed from the Indo-West Pacific (eastern coast of North America, the Red Sea, and Indonesia in the east) to the Atlantic region (Boyko & Harvey, 2002). These mole crabs commonly live in intertidal areas (swash zones) and engage in quick sand digging (Lastra et al., 2002).

The presence of mole crabs of the family Hippidae in Indonesia is well known, but few studies have been carried out on this group. Many members of the family Hippidae are present along Indonesia's seashore, including species of the genera *Hippa* (Fabricius, 1787) and *Emerita* (Scopoli, 1777). Other species include *H. admirabilis* (Thallwitz, 1892) in Papua and *H. celaeno* (de Man, 1896) in

Makassar, Sulawesi and Ambon, Moluccas (de Man, 1896). Information on the existence of mole crabs in the genus *Emerita* was reported by Efford (1976) during an expedition in Bengkulu, Sumatra.

Members of Hippidae are also widely distributed along the west coast of Sumatra and the south coast of Java. The abundance of *H. marmorata* (Hombron et Jacquinot, 1846) has been important in the field of exploration, which has contributed information on the geographical distribution of species of sand crab in Indonesia. *Hippa marmorata* is distributed across Tanzania, Hawaii, New South Wales in Australia, China, Japan, Western California, Panama, and the Galapagos Islands (Efford, 1972). However, the occurrence of this mole crab in Indonesia has not previously been recorded. The finding of *H. marmorata* documented in this report is the first in Indonesian territorial waters.

## MATERIAL AND METHODS

Figure 1 provides a map showing the locations where the specimens were collected. All specimens in each location were obtained by digging the sand in their habitat. The collected specimens were photographed with a Lumix G3 camera (Panasonic, Tokyo, Japan). They were preserved in 70% alcohol that was replaced with 96% alcohol in the laboratory, and then drawn using a camera lucida. Specimens were deposited in the Museum Zoologicum Bogoriense, Research Institute for Biology, Indonesian Institute of Science (LIPI) to obtain a registration number.

## SYSTEMATICS

Infraorder ANOMURA Macleay, 1838

Family HIPPIDAE Stimpson, 1858

Genus *Hippa* Fabricius, 1787

***Hippa marmorata*** (Hombron et Jacquinot, 1846)

*Remipes pacificus* Dana, 1852 (junior synonym)

TYPE MATERIAL. West Papua. Sorong, Jefman Island: 3 females, 3 males (MZB Cru 4153), 0°55'S, 131°07'E, coll. Fatmawati, 7 Feb 2015.

DIAGNOSIS. The carapace of *H. marmorata* was wide and flat (Figs. 2, 6). The submarginal comprises 20 to 40 rows. The carapace grooves were transverse and cream in colour, with short antennules and two median lobes (Fig. 3). The dactyl was not acute (obtuse) (Fig. 4). The antennules comprised two articles (Fig. 5).

EXAMINED MATERIAL. Lombok. Gili Meno Island, North Lombok, Gili Indah: 1 male, 1 female, 3 ov. females (MZB Cru. 4125), 8°20'S, 116°03'E, coll. Y. Wardiatno, A. Mashar, A. Farajallah, 22 Sept 2014. Sulawesi. Banggai Islands: 1 male, 2 ov. females (MZB Cru. 4126), 1°36'S, 123°29'E, coll. M. Sataral, 1 Nov 2013. Kei Islands. Tual: 3 males, 1 female, 6 ov. females (MZB Cru. 4127), 5°43'S, 132°42'E, coll. IPB, Aug 2014. West Papua. Sorong, Jefman Island: 3 females, 3 males (MZB Cru. 4153), 0°55'S, 131°07'E, coll. Fatmawati, 7 Feb 2015.

REMARKS. The systematics followed is that of Boyko et Harvey (1999). In total, 24 specimens

were collected. Fresh specimens exhibited a white (cream) and grey pattern on the carapace (see figure 2), a round to oval shape, and a carapace length of 2.0 to 2.5 cm. The anterior median lobe comprised two lobes (similar to *H. celaeno*), and 20 to 40 setose pit rows were present on the submarginal carapace. The main distinctive characteristic of these specimens was the number of left antennae with two articles (Osawa et al., 2010). The ocular peduncle was shorter than that in *H. adactyla*. The first pereopod commonly differed in length between the right and left sides.

## DISCUSSION AND CONCLUSIONS

*Hippa marmorata* are closely related to *H. ovalis* (Osawa et al., 2010), and the two species have similar antennulae, comprising two to three segments. The morphological characteristics of the specimens in this study were consistent with those of the Taiwan species *Hippa* and *Hippa marmorata* (Osawa et al., 2010). *Hippa marmorata* is in the family Hippidae and has been reported in Taiwan and Australia as a possible synonym of *H. pacifica* (Haig, 1974).

The species inhabits swash zones and engages in sand digging. It has been found along the west coast of Lombok, Banggai, Tual Island, and West Papua. No previous reports describe the discovery of this species in Sundaland. Its distribution is thus spread across regions around the Wallacea Line and to its eastern fringes. The *Hippa marmorata* collected from each location exhibit similar characteristics and colours. This species is also morphologically identical to *H. ovalis*, which is found in Sulawesi (Osawa et al., 2010). The specimens found in Papua displayed different carapace colour patterns in the male and female; the female specimen was relatively uniformly coloured, whereas the male was patterned.

Based on the distribution of this species in Taiwan (Osawa et al., 2010), its distribution is possibly affected by sea currents and various biological factors. The substrate textures of the west coast of Sumatra and of the south coast of Java are nearly identical, whereas the sand from Sulawesi, Lombok, and Papua differs and is white, similar to the colouring of the carapace of *H. marmorata*. The colour of the crabs' carapace is generally influenced



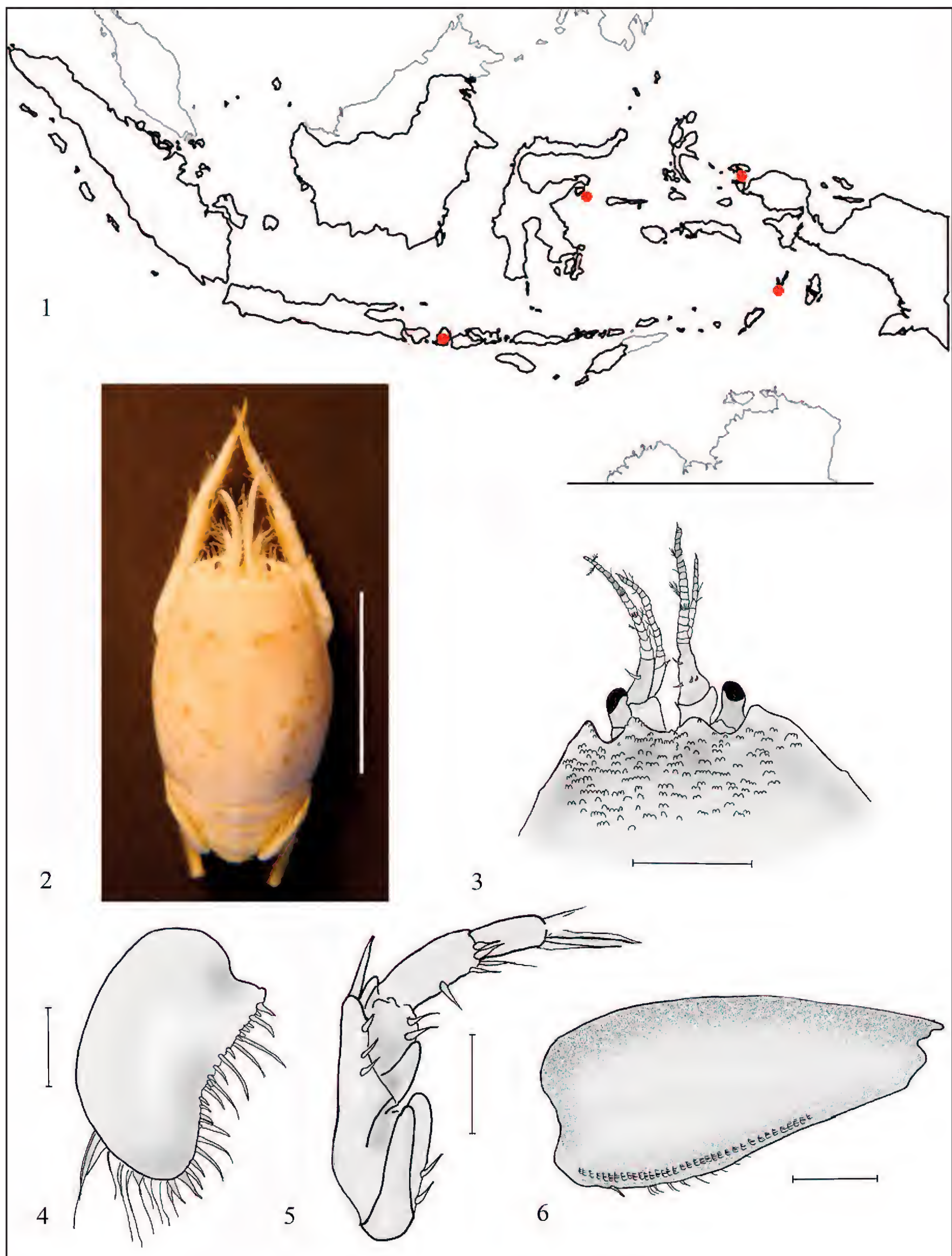


Figure 1. Map of Indonesia. Red circles indicate the locations where the specimens were collected. Figure 2. Specimen of *Hippa marmorata* (male) from Jefman Island, West Papua, Indonesia (scale: 1.0 mm). Figure 3. *Hippa marmorata* (26.50 mm) anterior carapace (length ratio = 20.78 mm). Fig. 4. Idem, dactyl (dorsal view). Fig. 5. Idem, antennulae. Fig. 6. Idem, submarginal carapace. Scale: Figs. 3, 6 = 4.0 mm, Figs. 4, 5 = 1.0 mm.

by the colour of the sand in their particular habitat (Wenner, 1972). More female than male specimens were found in this study. Ovigerous female species were dominant, indicating that the species is in regeneration (Forward et al., 2007).

The scarce information on the biology and distribution of *H. marmorata* does not provide any clear indication of the geographical distribution of this species in Indonesia. Further study is required to better understand its distribution, and phylogeographic analysis would be helpful in elucidating the source of this population in Indonesian intertidal zones.

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# On *Parthenina monozona* (Brusina, 1869) and its variability (Gastropoda Heterobranchia Pyramidellidae)

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## ABSTRACT

Study of type material of *Parthenina monozona* (Brusina, 1869), preserved at Croatian Natural History Museum (CNHM), consisting of four specimens, three of which well preserved, has proved that this species is senior synonym of *Parthenina intermixta* (Monterosato, 1884). Brusina's name has priority over Monterosato's name, because it is older. The polymorphism of this species is discussed.

## KEY WORDS

Pyramidellidae; *Parthenina*; *monozona*; type; recent; Mediterranean Sea.

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## INTRODUCTION

Study of type material is the only way to know some species not properly described/figured, because apart from personal interpretations of the various Authors, really some species have never been clarified. The present work illustrates the result of *Parthenina monozona* (Brusina, 1869) type material investigation. Even if the result of the study, that is the synonymy between *P. monozona* and *P. intermixta* (Monterosato, 1884), has been mentioned by most Authors (e.g. Aartsen, 1977; Linden & Eikenboom, 1992; Peñas et al., 1996), it was based on personal interpretations, without any study of typical or Author's named material.

## SYSTEMATICS

Subclass Heterobranchia J.E. Gray, 1840

Order Heterostropha P. Fischer, 1885

Superfamily Pyramidelloidea J.E. Gray, 1840

Family PYRAMIDELLIDAE J.E. Gray, 1840

Subfamily Chrysallidinae Saurin, 1958

Genus *Parthenina* B.D.D., 1883

Type species: *Odostomia interstincta* Montagu, 1803 = *Turbo interstinctus* J. Adams, 1797, European Seas by original designation

***Parthenina monozona*** (Brusina, 1869)

*Odostomia monozona* Brusina, 1869: 240

*Odostomia monozona* - Monterosato, 1872a: 31

*Odostomia monozona* - Monterosato, 1872b: 42

*Odostomia monozona* - Aradas & Benoit, 1874: 240

*Odostomia monozona* - Monterosato, 1875: 32

*Odostomia monozona* - Monterosato, 1877a: 39

*Odostomia (Pyrgulina) monozona* - Monterosato, 1877b: 35

- Odostomia (Pyrgulina) monozona* - Monterosato, 1877c: 421
- Odostomia monozona* - Monterosato, 1878: 93
- Odostomia monozona* - Stossich, 1876: 79
- Odostomia (Parthenina) jeffreysi* B.D.D., 1883: 170, pl. 20, figs. 8–10 (var.)
- Odostomia monozona* - Bucquoy et al., 1883: 173, pl. 20, figs. 12, 13 (see discussion)
- Pyrgulina monozona* - Monterosato, 1884: 87
- Pyrgulina intermixta* - Monterosato, 1884: 87
- Pyrgulina monozona* - Monterosato, 1885: 81
- Pyrgulina intermixta* - Monterosato, 1885: 81
- Odostomia monozona* - Brusina, 1886: 31
- Parthenina monozona* - Locard, 1886: 235
- Parthenina intermixta* - Locard, 1891: 144
- Parthenina monozona* - Locard, 1891: 145
- Parthenina monozona* - Ancey, 1898: 53
- Odostomia intermixta* - Pallary, 1900: 341
- Parthenina monozona* - Kobelt, 1903: 117–118
- Odostomia intermixta* - Pallary, 1912: 133
- Parthenina intermixta* - Cerulli-Irelli, 1914: 435, pl. 54, figs. 7–9
- Pyrgulina monozona* - Monterosato, 1917: 17
- Pyrgulina monozona* var. *attenuata* Monterosato - Monterosato, 1917: 17
- Pyrgulina (Parthenina) intermixta* - Fekih, 1969: 19, pl. 3, fig. 3
- Chrysallida monozona* - Parenzan, 1970: 125, fig. 45
- Parthenina intermixta* - Parenzan, 1970: 125
- Chrysallida monozona* - Ghisotti, 1972: 102
- Chrysallida (Parthenina) monozona* - Nordsieck, 1972: 93, pl. PI fig. 12 (see discussion)
- Chrysallida (Parthenina) intermixta* - Nordsieck, 1972: 93, pl. PI, fig. 10
- Chrysallida (Parthenina) intermixta* - Di Geronimo, 1975: 104
- Chrysallida monozona* - van Aartsen, 1977: 57–58
- Chrysallida intermixta* - van Aartsen, 1977: 57–59, pl. 3, fig. 21
- Chrysallida intermixta* - Ruggieri, 1982: 260
- Chrysallida intermixta* - Rolán Mosquera, 1983: fig. pag. 297, 298
- Chrysallida intermixta* - Mietto & Quaggiotto, 1983: 137, pl. 1, fig. 18
- Chrysallida intermixta* - van Aartsen et al., 1984: 49 n. 238
- Chrysallida intermixta* - Ballesteros et al., 1986: 43
- Chrysallida intermixta* - Martin-Sintes et al., 1990: 452
- Chrysallida intermixta* - Poppe & Goto, 1991: 49, 200
- Chrysallida monozona* - Riedl, 1991: 270, pl. 105
- Chrysallida intermixta* - Barash & Danin, 1992: 164
- Chrysallida intermixta* - van der Linden & Eikenboom, 1992: 20, fig. 33
- Chrysallida rara* - Gaglini, 1992: 149, fig. 130
- Chrysallida intermixta* - Cachia et al., 1993: 37
- Chrysallida intermixta* - Mifsud, 1994: 34, fig. 27
- Chrysallida intermixta* - Cecalupo & Quadri, 1996: 95, 118
- Chrysallida intermixta* - Peñas et al., 1996: 22, figs. 40, 42
- Chrysallida intermixta* - Giribet & Peñas, 1997: 53
- Chrysallida intermixta* - Cachia, 1999: 97, fig. pag. 98
- Chrysallida intermixta* - Öztürk & Çevik, 2000: 37
- Chrysallida intermixta* - Cachia et al., 2001: 87, pl. 13, fig. 11
- Chrysallida intermixta* - Öztürk et al., 2004: 60
- Chrysallida intermixta* - Micali & Nofroni, 2004: 179
- Chrysallida intermixta* - Coppini et al., 2005: 3
- Chrysallida intermixta* - Brunet Navarro & Capdevila, 2005: 36, 79 fig. 307
- Chrysallida intermixta* - Peñas et al., 2006: 44
- Chrysallida intermixta* - Trono, 2006: 61
- Chrysallida monozona* - Trono, 2006: 61
- Chrysallida intermixta* - Mazziotti et al., 2008: 78
- Chrysallida intermixta* - Cecalupo et al., 2008: 32, pl. 71, figs. 10–13.
- Chrysallida monozona* - Cosentino & Giacobbe, 2008: 166
- Chrysallida intermixta* - Vazzana, 2010: 71
- Chrysallida monozona* - Cossignani & Ardovini, 2011: 347
- Chrysallida intermixta* - Cossignani & Ardovini, 2011: 347
- Chrysallida intermixta* - Peñas & Rolán in Gofas et al., 2011: 373 (with SEM photos)
- Chrysallida intermixta* - Chirli & Micali, 2011: 34
- Parthenina intermixta* - Trono & Macrì, 2013: 36
- Chrysallida monozona* - Trono & Macrì, 2013: 36
- Chrysallida intermixta* - Öztürk, 2014: 28
- Parthenina monozona* - Giannuzzi-Savelli et al., 2014: 19, 67, figs. 163–168

ORIGINAL DESCRIPTION. Brusina (1869: 240): “*O. testa subulato-turrita obtusiuscula, nitida, lactea; anfractibus 5 ½ convexiusculis, sutura satis profunda disjunctis, longitudinaliter plicata, plicis subcontinuis, rectis, interstitia aequantibus, basi evanidis; cingulo transversali ad basin anfractuum*



*ornata; apertura ovata, tertiam totius longitudinis partem non aequante. - Long. 2 ¼ mill., lat. 1 mill.*" [shell elongate-turriculate, with blunt top, clear, white; 5 ½ whorls, quite convex, separated by very deep suture, axial ribs near aligned from one whorl to the other, straight, as large as the interspaces, evanescent on the base; one spiral ridge in the abapical portion of the whorls; aperture ovate; less than one third of the whole height. Length 2 ¼ mm, breadth 1 mm"].

**TYPE MATERIAL.** It is preserved at Croatian Natural History Museum (CNHM), with register number 1374. The material includes four specimens, three of which are in good conditions (Figs. 1–5), while one (Fig. 6) is quite eroded but possibly conspecific with the others. Specimen at figures 1–3 is designated as lectotype and the other three specimens are then paralectotypes. The well preserved specimens are clearly conspecific with *P. intermixta*, showing also the characteristic spiral striature in the interspaces between axial ribs. Brusina's name, that is older, has the priority and *P. intermixta* becomes junior synonym of *P. monozona*.

**TYPE LOCALITY.** Mica cape, Melada (Molat) island, Croatia. The Museum's label (Fig. 7) indicates this locality: "P Med. Mulat, Zadar".

**DESCRIPTION OF TYPE MATERIAL.** Shell conical, semi-transparent, white color. The protoconch is heterostrophic, making an angle of about 150° with the axis of the teleoconch (type B). The teleoconch is composed of about 5 whorls, flat, slightly gradate at the adapical suture, while abapically are angulated by the spiral on the initial whorls, gently curved in the last whorls and restricted toward the suture. The teleoconch whorls are covered by robust axial ribs, large as the interspaces, orthocline, straight. The ribs are in number of 20–22 on the last two whorls. The ribs extend, slightly attenuated, on the base. The spiral sculpture consists in a spiral rib placed at about ¼ of whorl height from abapical suture, present in all whorls. In the interspaces and on the base is present a microscopic spiral striature. The base is convex, covered by the extension of the axial ribs and the concentric spiral striature. Aperture oval. The columella is angulated in the middle. The columellar lip is slightly expanded. The inner lip forms a thin film over the adapical part of the aperture and joins the outer, to form a continuous peristome. The columellar plica is oblique, well

developed, reaching the margin of columellar lip about at the middle of it. The outer lip is simple, with external sculpture visible in transparency. Seen from the side, the outer lip is a little arched, following the flexuous profile of the axial ribs.

**VARIABILITY.** Protoconch: the angle of the protoconch ranges between 135° and 150° in the Adriatic specimens, while specimens from other areas normally show an angle of 135°. Outline and whorl profile: outline is conical, more or less slender (compare Fig. 8 with Fig. 11). The whorls may be flat, curved toward the adapical suture, angulated at the spiral rib and restricted toward the abapical suture (Figs. 9, 10, 12) or more regularly curved toward the sutures (Figs. 1–4, 8). Sometimes the adapical suture is coronate by the ribs, other times the ribs become weaker toward the suture, and it is linear (compare Figs. 8 and 12 with Figs. 9, 10, 11).

**Axial ribs:** in the type series the axial ribs are orthocline. Linden & Eikenboom (1992) indicate that "*Mostly the ribs incline to the left* [i. e. prosocline], *sometimes they are almost vertical, but they never incline to the right* [i. e. opisthocline]". In the studied material all the three cases have been observed, even if opisthocline only rarely (Fig. 9).

**Presence of axial ribs on the base:** the type series and all specimens from Vela Luka (Korčula island, Croatia) (Fig. 8) as well as the specimen from Otranto (Fig. 12) have the axial ribs extending all over the base, while specimens from other areas normally have the ribs ending at the periphery and only concentric striature on the base. Linden & Eikenboom (1992) states that the ribs are "*seldom decreasing or even continuing to the base*".

The specimens of *P. monozona* having elongate outline, well spaced ribs, spiral striature and deep suture may be easily separated from *P. interstincta*. The type series, as well as specimens found in other points of Middle and North Adriatic Sea has a form tending towards *P. interstincta*, from which may be separated (Fig. 13) for the more pointed apex, stronger axial ribs and spiral rib, spiral rib positioned more distant from the suture, presence of microscopic spiral striature in the ribs interspaces and on the base.

**DISTRIBUTION.** The species is distributed in the whole Mediterranean sea and along european coasts from Portugal to NW Spain (fide Linden & Eikenboom, 1992). Record of Rolán Mosquera (1983) for



Vigo was based on *P. interstincta* (Rolán pers. com., mail dated 26.08.2014). Not reported for west Africa. As fossil it occurs in the Pliocene of Tuscany and Tunisia and in the Pleistocene of Latium and Sicily.

## DISCUSSION

First investigated matter is the origin of synonymy with *P. intermixta*. Synonymy originates from Aartsen (1977) statement that “*the two species which Nordsieck described and figures with the name of intermixta (Monterosato) and monozona (Brusina) are in really only one species*” and the indicated synonymy. Possibly even Aartsen felt that the synonymy was not well proved, and this could be the reason for not using Brusina’s name, which has priority. Nordsieck (1972: 93, pl. PI fig. 12) drawing of *monozona* is based on a specimen from Ibiza, therefore this is no more than a Nordsieck’s personal interpretation of the species. Nordsieck’s (1972) drawing shows a specimen without spiral rib on the whorls, possibly following the name etymology of “*monozona*” which may be translated as “*single zone*”.

About Nordsieck’s drawings Ronald Janssen, curator of molluscs at Senckenberg Museum, Frankfurt/M (pers. comm. to R. Giannuzzi Savelli) tells us: “*You need to have always in mind that Nordsieck's «descriptions» are not necessarily based on his own specimens but a compilation also from literature! Also his drawings most often are «free style» compositions using also figures from the literature. This explains why only rarely specimens can be found which match his figures*”.

In addition to be highlighted that Brusina’s original description states “*cingulo transversali ad basim anfractuum ornata*”, where “*anfractuum*” is in the plural, therefore the spiral rib is indicated as present along all the whorls. What above does not prove at all the synonymy.

In the original description Brusina (1869) compares the new species only with his *Odostomia turbonilloides* Brusina, 1869 non Deshayes, 1861 (today the valid name is *Partulida incerta* (Milaschewitch, 1916)) from which it is anyway so different that a comparison is not needed.

Aradas & Benoit (1874) report that this species has been found in various Sicilian localities and

state that it is similar to *C. interstincta* but “*Quantunque la specie del Montagu presenti molte varietà, nessuna di quelle che abbiamo avuto per le mani, offre gli anfratti così arrotondati e la sutura così profonda come nella specie del Brusina*.” [Notwithstanding the several varieties of Montagu’s species, no one of those we had in our hands, has inflated whorls and deep suture as the Brusina’s species].

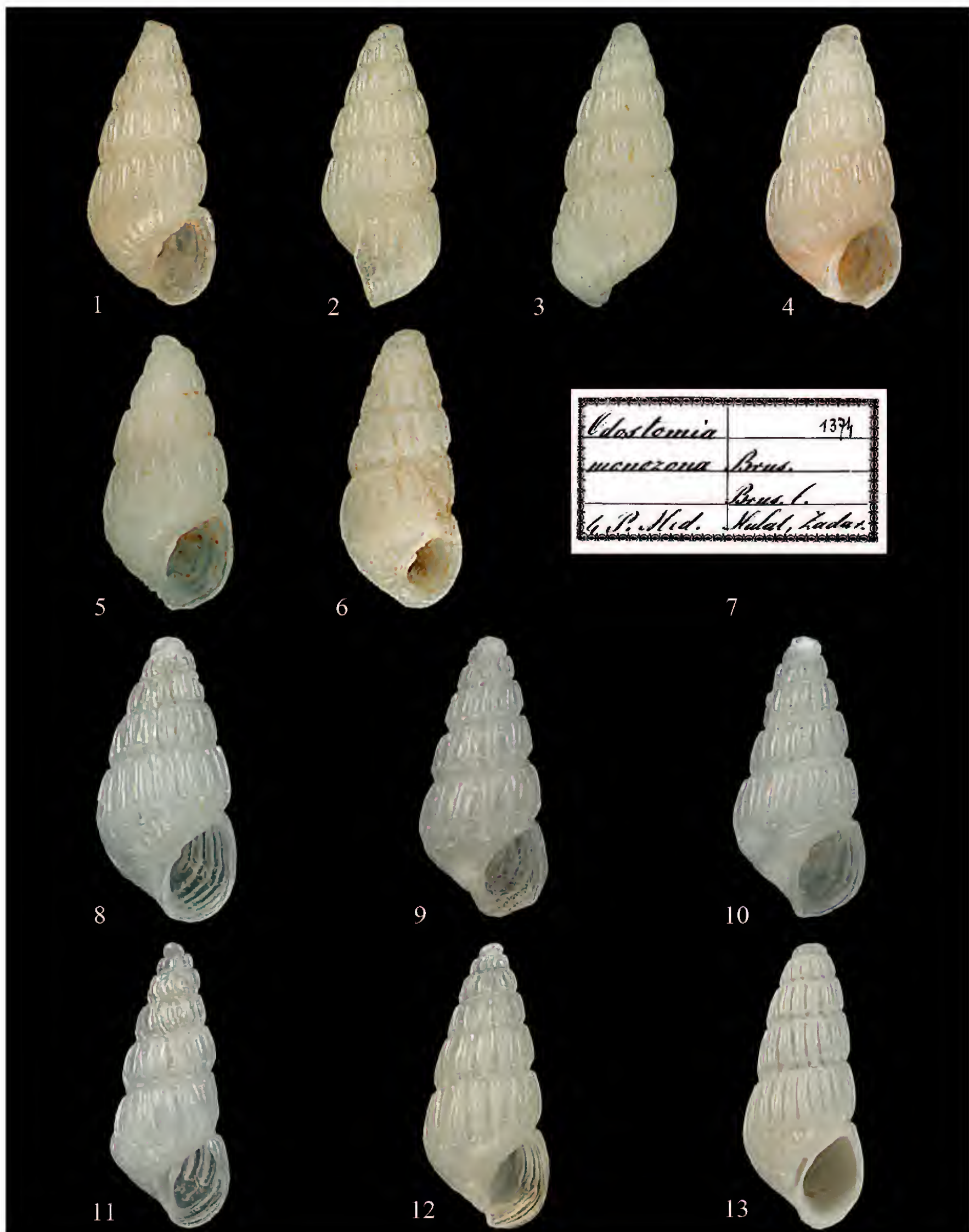
Monterosato (1872b) only lists the name as “var.” of *P. interstincta*, specifying “(ex typ.)”, to indicate that he examined the type material. However in this list also *P. suturalis* and *P. emaciata* are considered varieties of *P. interstincta*. Monterosato (1875) only lists the name as “var. 3” of *P. interstincta*, while later on (Monterosato, 1878) the species is listed as valid.

B.D.D. (1883: 173, pl. XX, figs. 12 and 13) describe and draw *Odostomia monozona*, but they do not mention the study of type material or the origin of material. The description mentions “*On remarque en outre sur les intervalles des côtes plusieurs rangées de trabicules qui entourent la partie inférieure des tours et se prolongent sur la partie médiane du dernier*” [in the interspaces of the ribs there are some rows of nodules that encircle the lower part of the whorls and extend up to the central part]. Kobelt (1903) considers that B.D.D. erroneously interpreted Brusina’s species and base his new species *Parthenina dollfusi* on *monozona* sensu B.D.D., “nec Brusina”. In B.D.D. it is not mentioned the study of *monozona* type material, therefore it is not surprising that these Authors wrongly interpreted Brusina’s species.

Monterosato (1884) states that he examined the type material, but includes, without any comment, the B.D.D.’s reference and indicates that this species is quite abundant. We suppose that he realised B.D.D.’s mistake, but due to good relation with these malacologists he avoided to highlight.

In proposing the new name *Pyrgulina intermixta*, Monterosato states: “*É la forma littorale Mediterranea erroneamente confusa con la P. interstincta, Mtg. che ha un maggiore numero di coste più sottili ed una forma più tarchiata. Varie forme; piuttosto frequente* [This is a Mediterranean littoral species, erroneously confused with *P. interstincta*, Mtg., that has more numerous and narrower axial ribs, and a stouter profile. Various forms; quite frequent]”.





Figures 1–7. *Parthenina monozona*, Melada (= Molat) island (Croatia), syntypes. Figs. 1–3: lectotype, H = 2.2 mm. Fig. 1: front view. Fig. 2: lateral view. Fig. 3: dorsal view. Fig. 4: paralectotype "A", H = 1.9 mm. Fig. 5: paralectotype "B", H = 2 mm. Fig. 6: paralectotype "C", H = 1.9 mm. Fig. 7: Museum's label. Figures 8–12. *Parthenina monozona*. Fig. 8: Vela Luka (Korčula island, Croatia), -26/32 m, H = 1.9 mm. Fig. 9: Algeciras (E), -3/6 m, H = 2.1 mm. Fig. 10: Umag (Croatia), beach, H = 2.2 mm. Fig. 11: Portopalo (Sicily, Italy), -3 m, H = 2.3 mm. Fig. 12: Otranto (South Adriatic Sea), -20 m, H = 2.7 mm. Figure 13. *Parthenina interstincta*, Marina di Camerota (Tyrrhenian Sea), - 25 m, H = 2.1 mm.



Pallary (1900) mentions *P. monozona* for Algerian coast.

Nordsieck (1972: 93, pl. PI, fig. 12) draws an un-realistic specimen of *Chrysallida monozona* from Ibiza, completely lacking spiral cords.

As discussed above, van Aartsen (1977: 58) considers *P. monozona* synonym of *P. intermixta* (Monterosato, 1884) only based on Nordsieck's drawings, but this is not correct from a taxonomic point of view, because the name *monozona* is much older therefore has the precedence over *Pyrgulina intermixta* Monterosato, 1884, that is a new name for *Odostomia (Parthenina) jeffreysi* B.D.D., 1883, non Koch & Weichmann, 1872 [*Turbonilla*], nec Bell A., 1871 [Menestho]. Really the B.D.D.'s name is not a secondary homonym of the others, therefore could be used. According to art. 23.9.1 of ICZN, dealing with the prevailing usage, it seems that the B.D.D.'s name has been immediately forgotten once Monterosato proposed the new name, therefore conditions of art. 23.9.1.1 "the senior synonym has not been used as valid name after 1899" and 23.9.1.2 "the junior synonym has been used (omissis) in at least 25 works published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years" are both complied with, therefore *O. (P.) jeffreysi* Bucquoy et al., 1883 is nomen oblitum, while *P. intermixta* is nomen protectum. Anyway this situation does not protect *intermixta* when it is proved to be junior synonym of *monozona*.

From what above it is clear that, apart the mistakes, many Authors, except Monterosato and possibly Pallary, feel that *P. monozona* (Brusina, 1869) is synonym of *P. intermixta* Monterosato, 1884, but they do not prefer Brusina's name because of the poor knowledge of his species. Monterosato is the only one who saw the type material, and is also the Author of *P. intermixta*, a species surely well known to him, who had close contacts with Dautzenberg. Monterosato (1884: 87) makes two sections under *Pyrgulina* and in the "group A" includes the species with axial ribs evanescent on the base: *P. monozona*, *P. intermixta*, *P. suturalis*, *P. emaciata* and *P. brevicula* Monterosato nomen nudum: = *P. monterosatii* (Clessin, 1900). As stated above, *P. monozona* is indicated as quite abundant. By comparing the above list with real situation and considering the indicated frequency, the result is that *P. monozona* is applied to the

species normally determined as *P. interstincta*, because the latter name is not mentioned. Really it is not possible to know if Monterosato had specimens by Brusina, if he saw the material and, due to the remarkable difference from Sicilian form, considered Brusina's species different from his *P. intermixta*, or if Brusina mixed together *P. monozona* and *P. interstincta* specimens, due to similarity and lacking of comparison with this latter species.

Similarly, Pallary (1900) mentions for Algerian coast *P. monozona* and *P. jeffreysi*, but not *P. interstincta*, which cannot be missing in that area.

From what above it is clear that some Authors used the name *monozona* for the species actually named *interstincta*.

*Chrysallida rara* Gaglini, 1992 ex Monterosato ms, based on material from Sfax (south Tunisia), clearly falls inside the range of variability of *P. monozona*, showing remarkable similarity with Sicilian forms, and is considered synonym.

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# Worldwide checklist of the island mutillid wasps (Hymenoptera Mutillidae)

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## ABSTRACT

The family of Mutillidae includes 776 taxa among species and subspecies recorded for 311 islands worldwide, whose distribution is provided in the present checklist. A brief review of some traits that characterize the insular faunas of these hymenopteran parasitoids is given. The main constraints to the dispersal on islands are due to the apterogyny and the occurrence of suitable hosts. Species richness is generally correlated with island size. Although probably still underestimated, the greatest number of species is found on Sri Lanka (82), Borneo (77), Madagascar (70) and Taiwan (61). Endemics are more than half (55%) of the whole insular mutillids and are found mostly in the oceanic islands and in those that have undergone to a long-time isolation. On the contrary, endemic genera are represented only on few islands (Madagascar, Sri Lanka and, secondarily, New Guinea, Sulawesi and Canary).

## KEY WORDS

Hymenoptera; Mutillidae; islands of the world; checklist; biogeography.

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## INTRODUCTION

The family Mutillidae includes 210 genera (Lelej & Brothers, 2008; see also Williams & Pitts, 2009; Williams et al., 2011; Brothers, 2012; Tu et al., 2014) and more than 4,300 species so far described. These latter are estimated to be about 6,000 (according to Lelej & Brothers, 2008), but their number is rather uncertain pending for further investigations that could lead to establish several new synonymies, because many species, and even a few genera, are still known only for one sex.

The strong sexual dimorphism typical of the members of this hymenopteran family makes indeed difficult the association between males (mostly winged) and females (all apterous), that is generally based on the direct observations of mating, although have been also used alternative methods such as live-caught females to attract

conspecific males (Manley, 1999) and molecular analysis (Pilgrim & Pitts, 2006).

Despite the uncertainty that still persists about the amount of true species belonging to this family, 428 (about 10% of those actually described), as well as 13 genera, are known to be exclusively distributed on islands. That confirms once again as the islands contribute disproportionately to the global biodiversity (Whittaker & Fernández-Palacios, 2006).

The occurrence of mutillids wasps on islands is however constrained by two morphological and biological traits: i) the low dispersal ability of the wingless females, and ii) their dependence on finding of suitable hosts, because Mutillidae are parasitoids that develop mainly on immature stages of other Hymenoptera (Brothers, 1989).

Consequently, the number of species on the islands presumably decrease with increase of their

degree of isolation, and thus the species richness should be greater on the continental islands rather than on the oceanic. By contrast, these latter could be more often characterized by processes of speciation and adaptive radiation.

The first information on insular mutillids is due to Fabricius (1775), who described *Mutilla antiguensis* from “insula Antigua” (Lesser Antilles, Caribbean Sea), a species still considered as valid although included among the taxa incertae sedis by Nonveiller (1990). Just few records were added during the first decades of the 19th century by Spinola (1839, 1841), Ghiliani (1842), Westwood (1843) and Lepeletier de Saint-Fargeau (1845), while several are those published since the second half of this century, thanks to the significant increase of the scientific expeditions to the islands carried out, among others, by naturalists such as Alfred Russell Wallace.

More recently, several studies specifically concerning the insular faunas of Mutillidae or that provide extensive faunal lists have been published (Arnone & Romano, 1995; Brothers, 2012; Brothers et al., 2011; Esaki, 1938; Hammer, 1950; Invrea, 1940, 1952c, 1955a, 1960, 1966; Krombein, 1949a, 1971, 1972; Lo Cascio & Romano, 2004; Lo Cascio et al., 2012; McCallan, 1990, 1991a; Mickel, 1928b, 1933, 1934, 1935; Nonveiller, 1972; Olsoufieff, 1938; Schembri, 1983; Strumia & Pagliano, 2014; Strumia et al., 2008; Terayama, 2005; Terayama et al., 2011; Tsuneki, 1972a, 1972b; Tsuneki et al., 1993; Turner, 1914; Turrise, 1999a), but a comprehensive and updated overview of all the available data, often scattered in papers not eminently dealing with this hymenopteran family, is still lacking.

The aim of the present paper is to provide a checklist of the faunal records of Mutillidae for the islands worldwide (including the estuarine but excluding fluvial and lacustrine ones). A wide literature has been therefore checked in order to achieve a list as exhaustive as possible, even if cannot be excluded that some data may have been neglected, hence reporting of any omissions or mistakes, as well as that of new records, is enthusiastically welcomed.

In light of the available data, it was also possible to outline the main biogeographical traits of the island faunas, which are briefly analyzed and discussed in a separate paragraph.

## MATERIAL AND METHODS

### *Geographical setting*

310 islands distributed between 55°N and 42°S where Mutillidae have been recorded are listed and grouped in alphabetical order with in the respective ecoregions in Table 1; another island (High Island) has been mentioned in Table 2 but not in Table 1 (see below).

Ecoregions follow the geographic boundaries given by Olson et al. (2001) with the only exception of Palearctic which is here subdivided in two different regions (Western and Eastern), and are listed in clockwise order from East of Greenwich and from North to South (see also Fig. 1).

As the boundary between Indo-Malay and Australasia is still debated (see Simpson, 1977; New, 2002; Halloway, 2009 and references therein), in the present paper the Weber line was adopted following the proposals given by Holt et al. (2013). According to Echenique-Diaz et al. (2009), all the Japanese islands that lie south of latitude 31° N (Ryūkyū or Nansei Archipelago) are assigned to the Indo-Malay, while Ogasawara (or Bonin) Islands belong to the Oceania.

Island's name and localization have been checked using both the Island Directory provided by UNEP ([islands.unep.ch/isldir.htm](http://islands.unep.ch/isldir.htm)) and the GeoNames Search facility of the US National Geospatial-Intelligence Agency ([geonames.nga.mil/ggmagaz/](http://geonames.nga.mil/ggmagaz/)).

Some Japanese islands were named using alternatively the suffix -shima or -jima. Asterisks after the name indicate \*) that the island is artificially connected to the mainland (or to the nearest main island), \*\*) it is composed by two sub-islands (data given in the next columns concern the overall island), \*\*\*) the toponym quoted in literature without further indications concerns an island group (whose name is reported into square brackets), hence geographical data are referred to its larger island.

Two-letter code of the country is given according to the International Organization for Standardization ([www.iso.org](http://www.iso.org)). Surface and elevation are respectively indicated in Km<sup>2</sup> (with 0.5 approximation) and in m a.s.l. Isolation index was calculated according to the proposals given by Dahl (1991; see also [islands.unep.ch/isldir.htm](http://islands.unep.ch/isldir.htm)) and successively assigned to a numerical class (e.g. values ranging



from 1 to 10 are included in the class 10, from 11 to 20 in the class 20, etc.).

### Data sources

Data were gathered through the examination of a wide literature which includes worldwide or regional catalogues and monographs (André, 1899–1903, 1902; Baltazar, 1966; Bischoff, 1920–1921; Blake, 1871; Brothers et al., 2011; Cameron, 1892; 1897, 1898, 1900; Dalla Torre, 1897; Krombein, 1972, 1979b; Lelej, 1985, 2002, 2005; Lepeletier de Saint-Fargeau, 1845; Mickel, 1928a; Nonveiller, 1990; Olsoufieff, 1938; Ramakrishna, 1916; Sichel & Radoszkowski, 1869–1870), reviews of genera and/or species groups (Bradley, 1916a; Lelej & Krombein, 2001; Ljubomirov, 2011; Manley & Pitts, 2007; Mickel, 1938, 1939, 1941; Nonveiller, 1979a, 1994, 1995a, 1995b; Nonveiller & Četković, 1995, 1996; Petersen, 1988; Pitts & McHugh, 2002; Radoszkowski, 1885; Reck Bartholomay, 2014; Suárez, 1988; Tu et al., 2014; Williams & Pitts, 2007, 2013; Williams et al., 2012), or museum collections (André, 1896a, 1896b, 1898, 1907–1908, 1908a, 1908b, 1909; Casolari & Casolari Moreno, 1980; Hashimoto & Nakanishi, 1997; Ljubomirov, 2006; Matteini Palmerini, 1992; Pagliano, 2005; Smith, 1855, 1879; Spooner, 1942; Starr, 1993; Suárez, 1959a; Taeger et al., 2005; Zavattari, 1910a).

Other relevant references which have been consulted are:

W-PALEARCTIC. Alicata et al. (1975), Archer (1986, 2014), Arnone & Romano (1995, 1998), Báez & Ortega (1978), Baldock (2014, 2015), Berland (1925), Bigot (1958), Bischoff (1928, 1933), Bischoff & Nonveiller (1965), Bordoni (1980), Broad (2014), Canovai et al. (2000), Cecconi (1895), Cocquempot & Chambon (1992), Cocquempot & Rungs (2009), Compte Sart (1959), Costa (1856–1860, 1882, 1883, 1885, 1887), Deschamps (1898), De Stefani-Perez (1885–1886, 1887a, 1887b, 1897), Edwards (1997), Failla Tedaldi (1887), Garcia Mercet (1913), Garcias Font (1953), Generani et al. (2001), Ghiliani (1842), Gribodo (1880), Grimshaw (1913), Haeseler (2008), Hammer (1950), Hohmann et al. (1993), Invrea (1940, 1941b, 1942, 1951, 1952a, 1952b, 1952c, 1953, 1954, 1955a, 1955b, 1957, 1958, 1960, 1962, 1964, 1966), King (1915), Lelej et al. (2003a),

Leo (1989), Lo Cascio (2000, 2014), Lo Cascio & Romano (2004), Lo Cascio et al. (1998), Mantero (1905, 1909), Masi (1933), Mellor (1932), Mingo & Compte (1963), Monastra (1989, 1990), Nagy (1972), Nonveiller (1972, 1979b), Nonveiller et al. (1998), Pagliano (2003, 2011), Pagliano & Matteini Palmerini (2014), Pagliano & Strumia (2000, 2007, 2013), Richards (1980), Riggio (1885), Riggio & De Stefani-Perez (1887), Romano (2004, 2012), Saunders (1880, 1881, 1896, 1901, 1904), Schembri (1983, 1984), Schulthess (1929), Spicer (1873), Spinola (1839), Stelfox (1933), Strumia & Pagliano (2014), Strumia et al. (2008), Suárez (1959b, 1970, 1975), Turrisi (1999a, 1999b), Valletta (1971, 1979), Villarúbia & Español (1933), Yarrow (1954), Yeo & Corbet (1995), and Zavattari (1910b, 1912).

AFROTROPIC. André (1895, 1899, 1901a, 1903a, 1903b, 1904, 1905, 1908b), Atkins & Webb (2013), Brancsik (1891), Friese (1900), Garcia Mercet (1903), Gerstaecker (1871), Invrea (1941a), Krombein (1939, 1951), Lelej & Harten (2006), Lo Cascio et al. (2012), McCallan (1991a), Nonveiller & Petersen (1995), Olsoufieff (1936), Paulian (1950), Saussure (1890–1892, 1891), Schulthess (1919), Schulz (1912), Seyrig (1936), and Viette (1957, 1978).

INDO-MALAY. André (1907a, 1907b), Ashmead (1905a, 1905b), Bingham (1895, 1897), Brown (1906), Cameron (1902a, 1902b, 1903, 1909), Chen (1957), Cockerell (1927), Dammermann (1923, 1948), Easton (2001), Garcia Mercet (1903), Green (1912), Hammer (1962), Haneda (1982), Ikudome & Yamane (2009), Invrea (1943), Krombein (1978, 1979a, 1981, 1982), Krombein & Lelej (1999), Krombein et al. (1999), Lelej (1993, 1995, 1996b), Matsumura & Uchida (1926), Mickel (1933, 1934), Motschulsky (1863), Murota (1973a, 1973b), Pagden (1938), Rohwer (1910), Sakagami et al. (1996), Saussure (1867a, 1867b), Smith (1857–1858, 1858, 1861a), Sonan (1931), Tennent (1859), Terayama (2005), Terayama et al. (2011), Tsuneki (1972b, 1972c, 1982a, 1982b, 1993a, 1993b), Tsuneki et al. (1993), Turner (1911), Wickwar (1908), Williams (1919), Yamane (1983), Yamane et al. (1992, 1999), Yasumatsu (1934), and Zavattari (1913a).

E-PALEARCTIC. Fukasawa & Miyano (2010), Haneda (1979), Hisamatsu (2004), Lelej (1996a, 2012), Lelej & Yamane (1992), Lelej et al. (2001), Matsumura (1911), Mickel (1936), Miyamoto



(1959), Nagase (2004), Nagase & Kawashima (2012), Ogawa et al. (2012), Paik (1994, 1995), Sakagami (1980), Sakagami et al. (1982), Smith (1873, 1874), Takahashi (1993), Terayama (2005), Terayama et al. (2011), Tsuneki (1962, 1972a, 1973), Tsurusaki et al. (2012), Vertyankin (2010), Yasumatsu (1931, 1937), and Yoshida (1989).

AUSTRALASIA. André (1901b, 1905), Brothers (1971, 2012), Cameron (1901, 1907), Hill (1955), Jennings et al. (2013), Krombein (1971), Mantero (1900), Mickel (1935), Montague (1914), Smith (1859, 1861b), Turner (1912, 1914), Valentine & Walker (1983), Villemant (2011), Westwood (1843), Williams (1945), and Zavattari (1913b).

INDO-MALAY AND AUSTRALASIA. Mickel (1937), O'Toole (1975), Pagden (1949), Smith (1861–1862, 1864a, 1864b, 1865), and Smith & Wallace (1873).

OCEANIA. Esaki (1938), Krombein (1949a), Sugiura et al. (2013), Takahashi & Shimizu (2007), Tsuneki (1984), and Yasumatsu (1936, 1950).

NEARCTIC. Bradley (1916b), Cockerell (1915), Cooper (1953), Deyrup & Manley (1986), Hurd (1951), McAlister & McAlister (1993), Ortiz (1976), Seavey (1892), and Wilson & Pitts (2009).

NEOTROPIC. Alayo Dalmau (1975), Ashmead (1896, 1900), Askew (1980, 1994), Cambra & Quintero Arias (1992, 1993), Cresson (1865), Dow (1931), Elliott & Elliott (1994, 1996), Elliot et al. (2002), Evans (1972), Fox (1900), Genaro (1997), Genaro & Torres (1999), Krombein (1949b), Lenko (1964), McCallan (1942, 1950, 1990, 1991b), Mickel (1926, 1928b, 1952, 1961), Perez-Gelabert (2008), Pitts (2007), Portuondo Ferrer & Fernández Triana (2004), Quintero Arias & Cambra (2001), Schuster (1946), Snelling (2005), Spinola (1841), Starr & Hook (2003), and William (1926).

Finally, the checklist includes data from the list of the specimens identified by the late B. Petersen and kept in the Zoological Museum of the University of Copenhagen (hereafter ZMUC, available at: [www.zmuc.dk/EntoWeb/collections-databaser/Hymenoptera](http://www.zmuc.dk/EntoWeb/collections-databaser/Hymenoptera)); from the distributional maps of BWARS ([www.bwars.com](http://www.bwars.com)); unpublished records

for Gavdos Island which are based on specimens identified by the late G. Nonveiller and kept in the Natural History Museum of Crete (A. Trichas, in litteris 20.i.1999); some other unpublished records have been given in details in Table 3.

### Statistical analysis

The effects of geographical predictors on faunal ensembles were assessed by using simple linear regression analysis with 95% confidence limits and performed with the open source software PAST version 3.04 (Hammer et al., 2001). Evaluation of diversity indices and UPGMA analysis were done using MVSP® (Multivariate Statistical Package), version 3.22. Numbers that follow  $\pm$  are referred to standard error.

### CHECKLIST

In Table 2, 719 species and 49 subspecies of Mutillidae are listed in alphabetical order with the respective insular distribution. Also, 8 species are indicated only at generic rank as quoted in literature; the only exception concerns “*Ephutomorpha*” sp. from New Guinea, recorded by André (1896a) and Mantero (1900) as the Australian *Ephutomorpha morosa* (Westwood, 1843), that according to Mickel (1935) probably represents a yet undescribed species.

Taxonomy and nomenclature follow those adopted by the most recent literature (see Data source), except for the genus *Smicromyrme* Thomson, 1870 which has been considered here as feminine gender (Romano & Lo Cascio, in preparation). For the species whose generic placement is still considered doubtful, genus name is indicated in quotes. That is the case, for instance, of the Madagascan species referred to genus *Trogaspidia* Ashmead, 1899 (see Brothers et al., 2011); or the whole genus *Ephutomorpha* André, 1902, appropriately defined by Krombein (1971) as a “portmanteau”, which currently includes many Australasian species that should be assigned to other genera yet undescribed (see also Brothers, 2012).

In the next column “E” indicates when a taxon is exclusively distributed on islands (specifying whether it is an endemic subspecies). *Ephucilla*



*viet* (Lelej, 1995) and *Glossotilla illudens* Invrea, 1941 are known only for Dang Kho (Vietnam) and Koyaama (Somalia), respectively, but it is unlikely that are really endemic of these small coastal islands and their distribution range probably includes neighboring continental areas. Conversely, *Smicromyrme mauromoustakisi* Invrea, 1940 from Cyprus is treated as endemic, because a record for Palestine (Invrea, 1965) should be referred to an yet undescribed species (P. Lo Cascio, unpubl. data). Also, *Wallacidia vicina* (Sichel et Radzowski, 1870) is considered endemic of some Australasian islands because a record for India given by André (1894) was not confirmed by Lelej (2005).

#### *Species and records excluded from the checklist*

Records of Mutillidae have been taken into account in the checklist when identified at least at generic rank and excluding those as: the “velvet ants” mentioned by Weiskittle (2004) for Pea Island (35.42N, 075.30W; code: US; surface: 127.5 Km<sup>2</sup>; max elevation: 10 m a.s.l.; isolation: 10); an unspecified number of mutillids found on Coiba Island (7.28N, 081.46W; PA; 503.0; 425; 20) reported by Nieves-Aldrey & Fontal-Cazalla (1997); one unidentified morphospecies recorded by Elliot & Elliot (1984) for Cat Island (24.24N, 075.31W; BS; 386.5; 122; 50); two unidentified morphospecies recorded by Pizarro-Araya et al. (2014) for Chañaral Island (29.01S, 071.34W; CL; 5.0; 145; 10); twenty-four (according to Callan et al., 2011) or even twenty-five unidentified morphospecies (according to www.padil.gov.au: 80/barrow-island/) found during recent faunal investigations on Barrow Island (20.47S, 115.24E; AU; 234.0; 64; 10).

From the checklist have also been excluded: *Dasylabris lybica* (Invrea, 1940), recorded for Malta in the list of ZMUC collections (see www.zmuc.dk/EntoWeb/collections-databaser/Hymenoptera), whose occurrence needs to be confirmed; *Ephutomorpha gaudens* Zavattari, 1913, described for New Guinea but successively neglected by Mickel (1935), whose taxonomic value needs hence to be clarified; *Hoplomutilla gabbii* (Blake, 1879), whose old records for Jamaica are due to the erroneous label of a specimen kept in the British Museum collections (Mickel,

1939); *Krombeinidia unifasciata* (Smith, 1855), whose record for Sulawesi (Smith, 1858; see also Smith & Wallace, 1873) is doubtful (Lelej, 2005); *Mutilla marginata* Baer, 1848, recorded for Sicily by André (1899-1903) but not confirmed by Turrisi (1999); *Myrmosa macrocephala* Olivier, 1811, described from Java, which belongs to the family Tiphiidae (see Lelej, 2005); *Odontomutilla urania* (Smith, 1857), whose terra typica is Melaka (Peninsular Malaysia) and not Borneo (Lelej, 2005); *Petersenidia gribodoi* (Magretti, 1892), whose records for Sumatra and New Guinea (Mantero, 1900) are due to erroneous identifications (Mickel, 1935); *Petersenidia subanalis* (Magretti, 1892), *Trogaspidia aulica* (Smith, 1855), *T. pilosella* (Magretti, 1892), *T. fortinata* (Cameron, 1899), and *T. pulchriceps* (Cameron, 1892), whose records for Sri Lanka (André, 1903a, 1907a; Bingham, 1897; Wickwar, 1908) have not been verified by Lelej (2005) and need to be confirmed; *Physetopoda discreta* (Cameron, 1897), whose record for Philippines (Bingham, 1897) is doubtful (Lelej, 2005); *Sinotilla decora* (Smith, 1879), whose record for Java (Zavattari, 1913a) is doubtful (Lelej, 2005); *Trogaspidia analis* (Lepeletier, 1845), whose records for Sri Lanka, Borneo, Sumatra, Bali, Sulawesi, Sumbawa, Ambon, Halmahera, Morotai, Ternate and Taiwan (André, 1907a; Zavattari, 1913b; Pagliano, 2005) have not been confirmed by Mickel (1935) and Lelej (2005); *Trogaspidia catanensis* (Rossi, 1794), whose record for Zanzibar (Zavattari, 1910a) must be certainly referred to another species; *Trogaspidia floralis* (Klug, 1829), whose record for Zanzibar (Bischoff, 1920-1921) is due to erroneous identification (Nonveiller & Petersen, 1995); *Trogaspidia rubripes* (André, 1901), recorded for Cyprus and supposed to be the opposite sex of *Neotrogaspidia hammeri* (Suárez, 1959) by Suárez (1959b), but recently treated as valid species by Lelej (2002), who however has excluded this island from its distribution range; *Trogaspidia repraesentans* (Smith, 1855), erroneously recorded by Smith & Wallace (1873) and Zavattari (1913b) for Borneo and Java, respectively (Mickel, 1935; Lelej, 2005); *Wallacidia sexmaculata* (Swederus, 1787) recorded by Lepeletier de Saint-Fargeau (1845) for Java from a specimen kept in the Spinola's collection (Regional Museum of Natural Sciences, Turin) doubtfully identified as



*Mutilla fuscipennis* Fabricius, 1804, but not confirmed by Lelej (2005; see also Pagliano, 2005).

Furthermore, from the distribution of some species included in the checklist have been omitted the following doubtful records: *Blakeius bipunctatus* (Latreille, 1792) for Cyprus by André (1899-1903), not confirmed by Invrea (1940) and Hammer (1950); *Dasylabris maura carinulata* (Dalla Torre, 1897) for Rhodes by Pagliano (2005), which need to be confirmed; “*Ephutomorpha*” *australasiae* (Fabricius, 1804) and “*Ephutomorpha*” *fausta* (Smith, 1863), given respectively for New Britain and New Guinea by André (1898), which need to be confirmed; *Krombeinella thoracica* (Fabricius, 1793) for Sicily by several authors, not confirmed by Suárez (1988); *Myrmilla mutica* (André, 1903) for Cyprus by Bogusch (2006), not confirmed by Ljubomirov (2011); *Mutilla europaea* Linnaeus, 1758 for Sardinia by Costa (1887), not confirmed by Arnone & Romano (1998); the same for the “Inner Hebrides” and “Outer Hebrides” without further information, respectively by the Scottish Aculeate List ([www.hbrg.org.uk/SAL/index.html](http://www.hbrg.org.uk/SAL/index.html)) and the Outer Hebrides Biological Recording (<http://www.ohbr.org.uk>); *Myrmilla erythrocephala* (Latreille, 1792) for Kerkyra, not confirmed by Ljubomirov (2011); *Myrmilla lezginica* (Radoszkowski, 1885) for “Cyclades” without further information by André (1899-1903); *Physetopoda halensis* (Fabricius, 1787) for Lampedusa by Pagliano (2003), that has been successively referred to another species (see Pagliano, 2011); *Physetopoda pusilla* (Klug, 1835) and *P. scutellaris* (Latreille, 1792) for Cyprus, respectively, by Bischoff (1933) and Invrea (1940) and by Hammer (1950), which need to be confirmed; *Platymyrmilla quinquefasciata* (Olivier, 1811) for Sicily by Pagliano & Strumia (2007) on the basis of a doubtful record from Spinola’s collection (see also Pagliano, 2005); *Ronisia ghilianii* (Spinola, 1843) for Cyprus by Hammer (1950), which need to be confirmed; *Smicromyrme rufipes* (Fabricius, 1878) for Malta by Pagliano (2005) and Pagliano & Strumia (2007), which need to be confirmed; *Smicromyrme vladani* Nonveiller, 1972 for Malta, given in the list of ZMUC collections (see [www.zmuc.dk/EntoWeb/collections-databaser/Hymenoptera](http://www.zmuc.dk/EntoWeb/collections-databaser/Hymenoptera)), that should be confirmed; *Timulla mediata persa* Mickel, 1938 for Trinidad by

Nonveiller (1990), as the same island is inhabited by the nominal subspecies; *Trogaspidia rhea rhea* (Mickel, 1933) for “Japan” by Mickel (1933) without further information; *Trogaspidia subintrans* (Sichel et Radoszkowski, 1870) for Taiwan by Zavattari (1913a), not confirmed by Lelej (2005), as well as those for Timor (Sichel & Radoszkowski, 1869-1870), Sumatra and Borneo (Zavattari, 1913b), although not mentioned by Lelej (2005), need to be confirmed; *Wallacidia merops* (Smith, 1860), for New Guinea by André (1896a) and Mantero (1900), that according to O’Toole (1975) are due to erroneous identifications; *Wallacidia oculata* (Fabricius, 1804) for Bali, Flores, Sumba and Palawan by Zavattari (1913b), need to be confirmed; *Yamanetilla taiwaniana* (Zavattari, 1913) for “Japan” in the ZMUC material ([www.zmuc.dk/EntoWeb/collections-databaser/Hymenoptera](http://www.zmuc.dk/EntoWeb/collections-databaser/Hymenoptera)) without further information.

On the contrary, the checklist includes a record of *Myrmosa unicolor* Say, 1824 given by Bradley (1917) for High Island (Outer Banks, Virginia, US); this latter belongs to a group of barrier islands whose number changes through time due to dynamic processes or violent storms and its name has not been localized in the recent maps, thus the island is not listed in Table 1.

Although often the toponym “Cayenne” was used in past to indicate also continental areas of French Guiana, data given by Spinola (1841) have been included in the checklist because the author refers explicitly to specimens collected by Leprieur “*dans les régions inexplorées de cette île*” (see Spinola, 1840). For the same reason, the checklist takes into account also the data given by Lepeletier de Saint-Fargeau (1845) concerning this estuarine island.

A separate discussion concerns *Myrmilla reunionis* described by Zavattari (1909), that according to Brothers et al. (2011) is likely not from Reunion Island. Pagliano (2005) has reported two specimens kept in the Spinola’s collection labelled as “*Mutilla doueyi*” (a female) and “*Mutilla douei*” (a male) and indicated to be from “Isola di Bourbon” (the former name of Reunion) without further information; the female was sent in loan in 1999 to Guido Nonveiller and probably has been lost. Waiting for a confirmation of the occurrence of mutillids on this island, the above records have not been included in the checklist.



Island	Localization	Code	Surface	Elevation	Isolation
W-PALEARCTIC					
Andros	37.50N 24.52E	GR	371.0	994	10
Anglesey*	53.30N 04.40W	GB	654.0	222	10
Antikythera	35.51N 23.18E	GR	21.0	379	20
Asinara	41.04N 08.28E	IT	51.0	408	20
Astypalea	36.34N 26.22E	GR	97.0	506	30
Bagaud	43.00N 06.21E	FR	0.5	69	10
Baltrum	53.43N 07.23E	DE	7.0	10	10
Brač	43.34N 16.65E	HR	395.5	778	10
Budelli	41.16N 09.20E	IT	1.5	87	20
Capraia	43.05N 09.90E	IT	19.5	447	10
Capri	40.55N 14.25E	IT	10.5	585	10
Cavallo	41.22N 09.15E	FR	1.0	32	20
Chergui (Cherguia)	34.43N 11.13E	TN	99.0	13	10
Chios	38.23N 26.02E	GR	822.5	1297	10
Čiovo	43.30N 16.17E	HR	28.0	218	10
Comino	36.00N 14.20E	MT	3.5	75	30
Conigli	35.30N 12.33E	IT	0.05	26	30
Corsica	42.15N 09.15E	FR	8741.5	2706	30
Cres	44.90N 14.45E	HR	406.0	650	10
Crete	35.20N 25.00E	GR	8336.0	2456	30
Cyprus	35.10N 33.40E	CY	9234.5	2021	30
Djerba	33.47N 10.53E	TN	523.0	53	10
Elba	42.80N 10.25E	IT	223.5	1019	10
Embiez	43.04N 05.47E	FR	1.0	57	10
Euboea (Evvoia)	38.50N 24.00E	GR	3670.0	1743	10
Favignana	37.55N 12.19E	IT	20.0	302	10
Filicudi	38.34N 14.33E	IT	9.5	774	20
Folegandros	36.37N 24.54E	GR	32.0	455	20
Fuerteventura	28.42N 14.00W	ES	1633.5	807	30
Gataya el Bahria	33.43N 10.42E	TN	1.5	6	10
Gavdos	34.50N 24.05E	GR	33.0	345	30
Giannutri	42.15N 11.06E	IT	2.5	93	10
Giglio	42.21N 10.54E	IT	21.0	498	10
Gomera	28.11N 17.20W	ES	359.0	1487	50
Gorgona	43.25N 09.54E	IT	2.5	255	10
Gozo (Ghawdex)	36.02N 14.15E	MT	67.0	191	30

Table 1/1. Islands' list with geographical data (continued).

Island	Localization	Code	Surface	Elevation	Isolation
W-PALEARCTIC					
Gran Canaria	27.95N 15.62W	ES	1530.0	1426	40
Great Britain	55.00N 02.00W	GB	209331.0	1333	20
Gremdi	34.45N 11.19E	TN	2.0	3	10
Hayling*	50.78N 00.96W	GB	30.0	15	10
Herm	49.47N 02.45W	GB	2.0	106	20
Hierro	27.75N 18.00W	ES	290.5	1500	50
Hvar	43.14N 16.80E	HR	297.5	626	10
Ireland	53.00N 08.00W	IE/GB	81638.0	1032	30
Ischia	40.73N 13.95E	IT	46.5	792	10
Jālitah (Galita)	37.31N 08.56E	TN	9.0	391	20
Karpathos	35.37N 27.08E	GR	311.0	1215	20
Kassos	35.23N 26.55E	GR	69.5	550	20
Kastellorizo (Megisti)	36.08N 29.35E	GR	12.0	273	10
Kea	37.36N 24.20E	GR	129.0	560	20
Kefalonia	38.12N 20.36E	GR	775.5	1628	20
Kerkyra	39.36N 19.51E	GR	626.0	906	10
Korčula	42.95N 16.90E	HR	271.5	502	20
Kornat	43.44N 15.22E	HR	32.5	207	10
Kos	36.49N 27.08E	GR	288.0	846	10
Krk	45.12N 14.65E	HR	405.0	569	10
Kythera	36.14N 22.59E	GR	278.0	525	10
La Maddalena	41.13N 09.24E	IT	20.0	156	20
Lampedusa	35.30N 12.35E	IT	20.0	133	30
La Palma	28.68N 17.85W	ES	690.0	2423	50
Lavezzu	41.20N 09.15E	FR	0.5	40	20
Levanzo	37.59N 12.20E	IT	5.5	277	10
Linosa	35.51N 12.52E	IT	5.5	195	40
Lipari	38.29N 14.56E	IT	37.5	602	20
Lošinj	44.35N 14.23E	HR	52.5	588	10
Mallorca	39.62N 03.00E	ES	3667.0	1445	40
Malta	35.90N 14.45E	MT	246.0	253	40
Man	54.23N 04.55W	GB	572.5	621	30
Marettimo	37.58N 12.03E	IT	12.0	684	20
Menorca	39.95N 04.10E	ES	692.0	355	40
Milos	36.41N 24.27E	GR	151.0	758	20

Table 1/2. Islands' list with geographical data (continued).



Island	Localization	Code	Surface	Elevation	Isolation
W-PALEARCTIC					
Mljet	42.44N 17.31E	HR	98.0	514	10
Mykonos	37.26N 25.23E	GR	107.5	372	20
Naxos	37.03N 25.29E	GR	436.0	1008	20
Nisyros	36.35N 27.10E	GR	41.5	698	10
Norderney	53.42N 07.14E	DE	27.0	10	10
Panarea	38.38N 15.04E	IT	3.5	421	20
Pano Koufonissi	36.56N 25.36E	GR	4.0	114	20
Pantelleria	36.47N 11.59E	IT	83.0	836	30
Paros	37.03N 025.11E	GR	191.0	771	20
Piana dell'Asinara	40.58N 008.13E	IT	1.5	24	20
Pianosa	42.34N 010.04E	IT	10.0	27	20
Poros	37.32N 023.28E	GR	31.0	358	10
Porquerolles	42.59N 006.12E	FR	1.0	142	10
Rab	44.46N 014.46E	HR	86.0	408	10
Rava	44.01N 015.04E	HR	3.5	98	10
Rhodes	36.11N 027.56E	GR	1410.0	1215	20
Salina	38.33N 014.50E	IT	26.5	962	20
Samothraki	40.27N 025.35E	GR	184.0	1600	20
San Domino	42.06N 015.29E	IT	2.0	116	10
Sant'Antioco*	39.05N 008.40E	IT	109.0	271	20
Santa Maria	41.17N 009.22E	IT	2.0	49	30
San Pietro	39.15N 008.28E	IT	51.5	211	20
Sardinia	40.10N 009.10E	IT	23949.0	1834	40
Sicily	37.55N 014.25E	IT	25710.0	3350	10
Skiathos	39.10N 023.27E	GR	49.5	436	20
Skopelos	39.07N 023.41E	GR	90.0	680	20
Skyros	38.51N 024.33E	GR	212.5	792	20
Šolta	43.22N 016.18E	HR	58.0	238	10
Spargi	41.14N 009.20E	IT	4.0	155	30
Stromboli	38.47N 015.12E	IT	12.0	920	20
Syros (Syra)	37.25N 024.54E	GR	94.0	422	20
Tavolara	40.54N 009.42E	IT	6.0	564	20
Tenerife	28.25N 016.58W	ES	2008.0	3718	50
Thassos	40.40N 024.39E	GR	386.0	1203	10
Thira	36.24N 025.26E	GR	73.0	565	20

Table 1/3. Islands' list with geographical data (continued).

Island	Localization	Code	Surface	Elevation	Isolation
W-PALEARCTIC					
Tinos	37.35N 025.08E	GR	193.0	650	20
Ugljan	44.04N 015.09E	HR	51.0	286	10
Ustica	38.42N 013.10E	IT	8.5	239	20
Vis	43.02N 016.09E	HR	90.0	587	10
Vulcano	38.23N 014.58E	IT	21.0	499	20
Wangerooge	53.47N 007.54E	DE	9.5	10	10
Wight	50.67N 001.31W	GB	391.5	395	20
Zakynthos	37.47N 020.46E	GR	419.5	756	10
AFROTROPIC					
Bioko (Fernando Poo, Macias Nguema)	03.50N 008.70E	GQ	1935.0	3008	20
Fundo	05.03S 039.38E	TZ	9.5	10	20
Grande Comore (Njazidja) [Comoros]***	11.38S 043.20E	KM	1013.0	2631	60
Inhaca	26.00S 032.56E	MZ	52.0	104	10
Koyaama (Coïama)	00.38S 042.20E	SO	4.5	9	10
Madagascar	19.00S 047.00E	MG	587713.5	2876	60
Mafia (Chole Shamba)	07.51S 039.47E	TZ	422.2	53	10
Nosy Be	13.19S 048.15E	MG	290.5	214	50
Nosy Boraha (Sainte Marie)	16.53S 049.55E	MG	222.0	150	50
Nosy Komba	13.28S 048.20E	MG	30.0	570	30
Pemba (Al Kuh Dra)	05.13S 039.77E	TZ	890.0	95	20
Príncipe	01.60N 007.40E	ST	148.5	948	40
Samha	12.09N 053.02E	YE	41.0	779	30
São Tomé	00.25N 006.62E	ST	855.0	2024	40
Socotra	12.28N 053.54E	YE	3625.0	1526	30
Zanzibar (Unguja)	06.08S 039.20E	TZ	1574.5	195	20
INDO-MALAY					
Amami Ōshima	28.17N 129.23E	JP	712.5	694	60
Anak Krakatau	06.05S 105.25E	ID	2.5	181	40
Balabac	07.95N 117.50E	PH	319.0	568	50
Bali	08.40S 115.20E	ID	5416.5	3031	40
Basilan	06.50N 122.00E	PH	1265.5	1011	50
Batbatan (Guintacan)	11.28N 121.54E	PH	11.0	90	50
Biliran	11.58N 124.47E	PH	501.0	1340	50

Table 1/4. Islands' list with geographical data (continued).



Island	Localization	Code	Surface	Elevation	Isolation
INDO-MALAY					
Borneo	01.00N 113.00E	ID/MY	748168.0	4095	50
Cebu	10.30N 123.75E	PH	4467.5	1097	50
Con Dao (Con Soon)	08.41N 106.37E	VN	51.5	577	10
Dang Kho (Dong Cong)	21.06N 107.36E	VN	20.0	190	10
Flores	08.70S 121.00E	ID	14154.5	2370	40
Hainan	14.16N 109.40E	CN	33210.0	1840	20
Hainan	14.16N 109.40E	CN	33210.0	1840	20
Iriomote-jima	24.20N 123.48E	JP	289.5	469	60
Ishigaki-jima	24.46N 124.20E	JP	221.0	526	60
Iwo-jima	30.47N 130.17E	JP	11.0	703	40
Java (Jawa)	07.50S 110.00E	ID	138793.5	3676	50
Kakeromajima (Kageroma)	28.07N 129.14E	JP	77.0	326	60
Kangean	06.90S 115.35E	ID	188.0	390	40
Kuchinoshima	29.58N 129.55E	JP	13.5	628	60
Labuan	05.18N 115.13E	MY	75.0	85	40
Leyte	10.80N 125.00E	PH	7367.5	1349	50
Lombok	08.60S 116.36E	ID	4625.0	3726	50
Luzon	16.00N 122.00E	PH	109965.0	2934	50
Mactan	10.17N 123.57E	PH	62.0	10	30
Magong (Hokoto, Penghu)	23.34N 119.37E	TW	90.0	56	30
Mindanao	07.50N 125.00E	PH	97530.0	2954	70
Mindoro	12.90N 121.10E	PH	10572.0	2585	50
Miyakojima (Naaku)	24.16N 132.18E	JP	55.5	115	60
Negros	10.00N 123.00E	PH	13074.5	2435	50
Okinawa-jima	26.50N 128.00E	JP	1200.0	498	60
Palawan	10.00N 118.70E	PH	12188.5	2085	60
Paliat	06.58S 115.37E	ID	42.0	287	40
Panaitan	06.35S 105.12E	ID	118.5	187	40
Panay	11.10N 122.60E	PH	12011.0	2049	60
Peucang (Ujung Kulon)	06.44S 105.15E	ID	4.5	70	20
Phong Vong (Hon Vong)	09.55N 104.00E	VN	0.5	65	10
Polillo	14.85N 121.95E	PH	629.0	327	40
Rakata Besar (Krakatau)	06.09S 105.26E	ID	11.5	813	40
Rakata Kecil	06.05S 105.27E	ID	2.5	42	40
Samar	11.90N 125.30E	PH	12849.5	850	60

Table 1/5. Islands' list with geographical data (continued).

Island	Localization	Code	Surface	Elevation	Isolation
INDO-MALAY					
Sertung	06.05S 105.22E	ID	7.5	182	40
Sibuyan	12.50N 122.60E	PH	465.0	2057	40
Simeulue (Simalu)	02.65N 096.10E	ID	1754.0	481	20
Singapore (Pulau Ujong)	01.35N 103.80E	SG	536.5	163	10
Solor [Solor] <sup>***</sup>	08.28S 123.00E	ID	1292.0	1737	40
South Andaman	11.95N 092.67E	IN	1211.0	366	40
Sri Lanka	07.80N 080.60E	LK	67654.5	2524	20
Sulawesi (Celebes)	02.00S 121.00E	ID	180681.0	3455	60
Sumatra (Sumatera)	00.50S 102.00E	ID	443066.0	3804	20
Sumba (Soemba)	06.65S 120.00E	ID	10710.5	1225	50
Sumbawa (Soembawa)	08.50S 118.00E	ID	14386.0	2722	40
Takeshima	30.48N 130.25E	JP	4.0	220	40
Taiwan (Formosa)	23.38N 121.07E	TW	34506.5	3952	40
Tanegashima	30.36N 130.59E	JP	447.5	282	40
Tawi Tawi	05.20N 120.00E	PH	580.5	549	40
Thanh Lân (Thanh Lam)	21.01N 107.49E	VN	13.5	250	10
Thao Thu	09.17N 103.28E	VN	10.0	200	30
Timor	09.30S 125.50E	ID	28418.0	2963	40
Tokunoshima	27.46N 128.57E	JP	105.0	645	50
Yakushima	30.20N 130.31E	JP	500.5	1935	40
E PALEARCTIC					
Hachijō-jima	33.06N 139.37E	JP	62.5	854	40
Hokkaidō	43.00N 142.50E	JP	78719.5	2290	40
Honshū	36.50N 138.00E	JP	225800.5	3776	30
Izu Ōshima	34.44N 139.24E	JP	91.0	764	30
Jeju (Cheju, Quelpart)	33.23N 136.23E	KR	1848.0	1950	30
Kunashir	44.10N 145.90E	RU	1612.0	1820	40
Kyūshū	32.60N 131.10E	JP	37437.0	1788	30
Namhae	34.48N 127.46E	KR	300.0	786	10
Okushiri	42.09N 139.28E	JP	143.0	584	40
Sakhalin	50.00N 142.50E	RU	72493.0	1609	10
Shikoku <sup>*</sup>	33.40N 133.40E	JP	18554.5	1981	40
Shimoshima [Amakusa] <sup>***</sup>	32.23N 130.06E	JP	924.0	460	30
Tsushima <sup>**</sup>	34.40N 129.09E	JP	708.5	649	30

Table 1/6. Islands' list with geographical data (continued).



Island	Localization	Code	Surface	Elevation	Isolation
AUSTRALASIA					
Ambon (Amboina)	03.64S 128.19E	ID	806.0	1031	50
Bacan (Bachian, Batjan)	00.57S 127.58E	ID	1900.0	2011	50
Baronga (Paronga)	06.15S 150.28E	PG	2.0	30	30
Biak	01.00S 136.00E	ID	1832.0	740	30
Bougainville	06.20S 155.50E	SO	9318.0	2792	70
Buka	05.30S 154.70E	SO	682.5	365	60
Buru (Boeroe)	03.45S 126.56E	ID	8473.0	2700	50
Choiseul	07.01S 156.56E	SO	2970.5	1067	70
Daru	09.05S 143.12E	PG	14.5	27	30
Espiritu Santo	15.39S 166.85E	VU	3955.5	1877	70
Gebe (Gebeh)	00.04S 129.26E	ID	420.0	396	50
Gizo (Ghizo)	08.07S 156.75E	SO	35.0	<100	70
Grande Terre	21.40S 165.50E	NC	16648.5	1628	90
Guadalcanal	09.60S 160.20E	SO	5353.0	2447	80
Halmahera (Gilolo)	00.50N 128.00E	ID	18039.5	1635	60
Hermite	20.27S 115.31E	AU	10.0	54	10
Kai (Nuhu Yuut)	05.60S 133.00E	ID	549.5	801	50
Kiriwina	08.50S 151.05E	PG	266.5	55	50
Kolombangara (Nduke)	07.95S 157.05E	SO	688.0	1768	70
Larat (Tanimbar)	07.17S 131.81E	ID	216.0	55	40
Lihir (Niolam, Gerrit Denys)	03.14S 152.62E	PG	320.0	700	60
Makira (San Cristobal)	10.60S 161.85E	SO	3190.5	1250	80
Malaita	09.00S 161.00E	SO	3836.0	1433	80
Misool (Mysol)	01.87S 130.17E	ID	2033.5	561	50
Mono [Treasury] <sup>***</sup>	07.21S 155.34E	SO	36.0	350	70
Morotai (Morty)	02.34N 128.50E	ID	2266.5	1090	50
New Britain	05.70S 150.90E	PG	35144.5	2334	50
New Georgia	08.25S 157.60E	SO	2036.5	860	80
New Guinea	06.00S 140.50E	ID/PG	785753.0	5030	40
New Ireland	03.70S 152.50E	PG	7404.5	2150	50
New Hanover (Lavongai)	02.30S 150.15E	PG	1800.0	900	50
Nggela (Florida)	09.08S 160.25E	SO	386.0	<200	80
Normanby (Duau)	10.00S 151.00E	PG	1040.0	1100	40
North Island	38.00S 176.00E	NZ	111583.0	2796	90
Pavuvu [Russell] <sup>***</sup>	09.05S 159.10E	SO	120.0	543	80
Pins (Kounie)	22.60S 147.67E	NC	141.5	110	60

Table 1/7. Islands' list with geographical data (continued).

Island	Localization	Code	Surface	Elevation	Isolation
AUSTRALASIA					
Ranongga (Ronongo, Ganonga)	08.05S 156.55E	SO	148.0	869	70
Rendova	08.55S 157.30E	SO	411.5	1060	80
Roon (Ron)	02.23S 134.33E	ID	18.0	200	20
Salawati	01.15S 130.92E	ID	1623.0	925	40
Santa Isabel (Bughotu, Santa Ysabel)	08.00S 159.10E	SO	3665.0	1219	80
Savo	09.17S 159.83E	SO	30.0	485	80
Seram (Ceram)	03.26S 129.50E	ID	17454.0	3027	50
Taliabu [Sula] <sup>***</sup>	01.83S 124.88E	ID	2960.0	1638	50
Tanahbesar (Wokam) [Aru] <sup>***</sup>	05.79S 134.53E	ID	1604.0	239	30
Tasmania	42.00S 146.50E	AU	65022.0	1617	40
Ternate	00.84N 127.42E	ID	111.5	1721	40
Trimouille	20.23S 115.33E	AU	5.0	36	10
Tulagi (Tulaghi)	09.06S 160.08E	SO	5.5	200	70
Umboi (Rooke)	05.38S 147.55E	PG	930.0	1655	30
Vella Lavella (Mbilua)	07.75S 156.65E	SO	629.0	808	70
Waigeo (Amberi)	00.22S 130.84E	ID	3153.5	993	50
Woodlark (Muyuw)	09.10S 152.80E	PG	874.0	225	60
Yapen (Japen, Jobi)	01.85S 136.34E	ID	2278.0	1496	20
Yule	08.48S 146.31E	PG	16.0	33	20
OCEANIA					
Chichi-jima	27.04N 142.12E	JP	25.0	324	90
Nishi-jima	27.07N 142.10E	JP	0.5	100	90
Peleliu (Beliliou)	07.23N 134.25E	PW	13.0	30	90
NEARCTIC					
Anacapa	34.00N 119.37W	US	3.0	279	20
Bay Farm <sup>*</sup>	37.43N 122.13W	US	16.0	20	10
Catalina (Santa Catalina)	33.39N 118.43W	US	193.0	648	20
Cedar Key <sup>*</sup>	29.08N 083.02W	US	2.5	5	10
Cumberland	30.51N 081.26W	US	147.5	20	10
Fishers	41.16N 071.59W	US	11.0	5	10
Gardiners	41.05N 072.06W	US	12.0	15	10
Long Island <sup>*</sup>	40.48N 073.11W	US	3629.0	122	10
Matagorda	28.09N 096.44W	US	157.5	7	10

Table 1/8. Islands' list with geographical data (continued).



Island	Localization	Code	Surface	Elevation	Isolation
NEARCTIC					
Nantucket	41.28N 070.80W	US	272.5	9	10
Padre	26.50N 097.23W	US	541.0	15	10
Penikese	41.27N 070.55W	US	0.5	25	10
Sanibel*	26.26N 082.06W	US	86.0	1	10
Santa Cruz	34.00N 119.74W	US	256.0	753	20
St. Simon's	31.09N 081.23W	US	46.0	3	10
Tybee*	32.00N 080.50W	US	7.0	3	10
Vancouver	49.67N 125.50W	CA	31848.5	2192	10
NEOTROPIC					
Antigua	17.04N 061.47W	AG	277.0	402	50
Arapiranga	01.20S 048.34W	BR	44.0	30	10
Baltra (South Seymour)	00.45S 090.25W	EC	27.0	100	60
Cañas	07.24N 080.19W	PA	7.5	30	10
Cayenne	04.52N 052.19W	GF	207.0	234	10
Coiba	07.29N 081.45W	PA	493.0	400	20
Cuba	21.50N 079.00W	CU	105805.5	1975	40
Dominica	15.45N 061.45W	DM	787.5	1447	50
Eleuthera	25.04N 076.08W	BS	518.0	60	50
Great Exuma	23.32N 075.50W	BS	204.5	39	50
Grenada	12.10N 061.70W	GD	323.0	840	40
Guadeloupe**	16.20N 061.70W	GP	1496.5	1467	40
Guana	18.30N 064.37W	VG	3.5	30	50
Hispaniola	19.00N 071.00W	DO/HT	73929.0	3098	50
Juventud (Pinos)	21.65N 082.78W	CU	2237.5	310	40
Jamaica	18.20N 072.25W	JM	11189.5	2256	50
Little Cayman	19.70N 080.00W	KY	28.0	14	50
Marajó	00.55S 049.40W	BR	40100.0	40	10
Marco (Ilha do Marco)	00.35S 047.26W	BR	15.0	12	10
Maria Madre	21.60N 106.58W	MX	145.0	616	20
Martinique	14.65N 061.00W	MQ	1166.5	1397	50
Mustique	12.52N 061.10W	VC	5.5	150	50
Puerto Rico	18.20N 066.45W	PR	9100.0	1338	50
Rey	08.22N 078.53W	PA	234.0	86	20
Santa Cruz (Indefatigable)	00.60S 090.35W	EC	986.0	864	70

Table 1/9. Islands' list with geographical data (continued).

Island	Localization	Code	Surface	Elevation	Isolation
NEOTROPIC					
Santo Amaro <sup>*</sup>	23.56S 043.21W	BR	143.0	4	10
St. Croix	17.75N 064.75W	VI	214.0	355	40
St. John	18.35N 064.75W	VI	50.0	389	40
St. Vincent	13.15N 061.11W	VC	381.0	1234	40
Taboga	08.47N 079.33W	PA	12.0	300	20
Trinidad	10.40N 061.30W	TT	5008.5	940	20

Table 1/10. Islands’ list with geographical data.

SPECIES	ISLANDS	
<i>Acrophotopsis eurygnatha</i> Schuster, 1958	Maria Madre	
<i>Ancistrotilla aenigmatica</i> Brothers, 2012	Grande Terre, Pins	E
<i>Ancistrotilla azurea</i> Brothers, 2012	Espiritu Santo	E
<i>Ancistrotilla bluensis</i> Brothers, 2012	Grande Terre	E
<i>Ancistrotilla caledonica</i> (André, 1896)	Grande Terre, Pins	E
<i>Ancistrotilla carbonaria</i> (Smith, 1855)	Tasmania	E
<i>Ancistrotilla nigra</i> Brothers, 2012	Grande Terre	E
“ <i>Andreimyrme</i> ” <i>annexa</i> (Cameron, 1909)	Borneo	E
<i>Andreimyrme davidi</i> (André, 1898)	Taiwan	
<i>Andreimyrme neaera</i> (Mickel, 1935)	Borneo	E
<i>Andreimyrme sarawakensis</i> Lelej, 1996	Borneo	E
<i>Andreimyrme substriolata</i> (Chen, 1957)	Taiwan	
“ <i>Andreimyrme</i> ” <i>virinata nitela</i> (Mickel, 1934)	Mindanao, Negros, Samar	E (ssp)
“ <i>Andreimyrme</i> ” <i>virinata virinata</i> (Mickel, 1934)	Biliran, Luzon, Mindanao, Panay, Samar, Sibuyan	E (ssp)
“ <i>Andreimyrme</i> ” <i>volupia</i> (Mickel, 1935)	Borneo	E
<i>Artiotilla biguttata</i> (Costa, 1858)	Brač, Corsica, Cyprus, Hvar, Korčula, Rhodes, Sicily	
<i>Ascetotilla carinata</i> (Smith, 1859)	Morotai, New Britain, New Guinea, Tanahbesar	E
<i>Ascetotilla clypeata</i> Brothers, 1971	New Guinea	E
<i>Ascetotilla ferruginata</i> Brothers, 1971	New Guinea	E
<i>Ascetotilla francae</i> Brothers, 1971	New Guinea	E
<i>Ascetotilla inermis</i> Brothers, 1971	New Guinea	E
<i>Ascetotilla notidana</i> Brothers, 1971	New Guinea	E
<i>Ascetotilla stanleyi</i> Brothers, 1971	New Guinea	E
<i>Ascetotilla uncinata</i> Brothers, 1971	New Guinea	E
<i>Aureotilla dispilota</i> (Sichel et Radoszkowski, 1869)	Madagascar	E
<i>Aureotilla hebraea</i> (Bischoff, 1920)	Madagascar	E

Table 2/1. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Aureotilla madecassa</i> (Saussure, 1890)	Madagascar, Nosy Be	E
<i>Aureotilla preclara</i> (Bischoff, 1920)	Madagascar	E
<i>Aureotilla tulearica</i> (Olsoufieff, 1938)	Madagascar	E
<i>Australotilla modesta</i> (Smith, 1855)	Hermite, Trimouille	
<i>Bethsmymmilla alticola</i> Krombein et Lelej, 1999	Sri Lanka	E
<i>Bischoffitilla aesyca</i> (Cameron, 1902)	Borneo, Java	E
<i>Bischoffitilla ardescens</i> (Smith, 1873)	Amami Ōshima, Yakushima, Honshū, Izu Ōshima, Kyūshū, Shikoku, Tsushima	E
<i>Bischoffitilla aspera</i> (Cameron, 1900)	Sri Lanka	E
<i>Bischoffitilla brachynota</i> (Chen, 1957)	Taiwan	E
<i>Bischoffitilla byblis</i> (Mickel, 1934)	Luzon, Sibuyan	E
<i>Bischoffitilla calliopeia</i> (Mickel, 1935)	Borneo	E
<i>Bischoffitilla cardea</i> (Mickel, 1935)	Borneo	E
<i>Bischoffitilla carinulifera</i> (André, 1908)	Taiwan	E
<i>Bischoffitilla cebuensis</i> (Tsuneki, 1993)	Cebu	E
<i>Bischoffitilla clypealis</i> (Mickel, 1935)	Borneo	E
<i>Bischoffitilla concava</i> (Mickel, 1934)	Mindanao	E
<i>Bischoffitilla denticollis</i> (Motschulsky, 1863)	Sri Lanka	E
<i>Bischoffitilla deserta</i> (Smith, 1879)	Java, Kangean, Luzon, Sulawesi	E
<i>Bischoffitilla dictynna</i> (Mickel, 1934)	Mindanao	E
<i>Bischoffitilla disjuncta</i> (Mickel, 1934)	Luzon	E
<i>Bischoffitilla duplisquamata</i> (Chen, 1957)	Taiwan	E
<i>Bischoffitilla edolata</i> (Cameron, 1900)	Sri Lanka	E
<i>Bischoffitilla eminula</i> (Mickel, 1934)	Luzon	E
<i>Bischoffitilla erdae</i> (Zavattari, 1913)	Taiwan	E
<i>Bischoffitilla ernesti</i> (Cameron, 1900)	Sri Lanka	E
<i>Bischoffitilla facilis</i> (Smith, 1860)	Sulawesi	E
<i>Bischoffitilla formosana</i> (Zavattari, 1913)	Taiwan	E
<i>Bischoffitilla fucosa</i> (Mickel, 1934)	Mindanao	E
<i>Bischoffitilla galatea</i> (Mickel, 1934)	Luzon	E
<i>Bischoffitilla imparilis</i> (Mickel, 1934)	Luzon	E
<i>Bischoffitilla indecora</i> (Cameron, 1898)	Sri Lanka	E
<i>Bischoffitilla indocila</i> (Cameron, 1900)	Sri Lanka	E
<i>Bischoffitilla koxiana</i> (Chen, 1957)	Taiwan	E
<i>Bischoffitilla mickeli</i> (Chen, 1957)	Taiwan	E
<i>Bischoffitilla muii</i> (Mickel, 1935)	Java	E
<i>Bischoffitilla multidentata</i> (André, 1896)	Simeulue, Sumatra	
<i>Bischoffitilla murotai</i> (Tsuneki, 1993)	Amami Ōshima, Okinawa-jima	E
<i>Bischoffitilla oblectabilis</i> (Mickel, 1934)	Luzon	E

Table 2/2. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Bischoffitilla ocypote</i> (Mickel, 1934)	Luzon	E
<i>Bischoffitilla palaca</i> (Cameron, 1902)	Borneo, Sumatra	E
<i>Bischoffitilla persuasa</i> (Cameron, 1900)	Sri Lanka	E
<i>Bischoffitilla puerilis</i> (Cameron, 1897)	Sri Lanka	
<i>Bischoffitilla puliensis</i> (Tsuneki, 1972)	Taiwan	E
<i>Bischoffitilla pungens</i> (Smith, 1873)	Yakushima, Hachijō-jima, Honshū, Kyūshū, Shikoku	E
<i>Bischoffitilla roxane</i> (Mickel, 1934)	Negros	E
<i>Bischoffitilla saffica</i> (Zavattari, 1913)	Sulawesi	E
<i>Bischoffitilla sauteri lingnani</i> (Mickel, 1933)	Hainan	
<i>Bischoffitilla sauteri sauteri</i> (Zavattari, 1913)	Taiwan	E (ssp)
<i>Bischoffitilla subdebilis</i> (Mickel, 1934)	Luzon	E
<i>Bischoffitilla subtriangularis</i> (Mickel, 1934)	Mindanao	E
<i>Bischoffitilla sulpicilla</i> (Mickel, 1934)	Borneo, Mindanao	E
<i>Bischoffitilla teuta mindanaonis</i> (Tsuneki, 1993)	Mindanao	E (ssp)
<i>Bischoffitilla teuta teuta</i> (Mickel, 1934)	Luzon	E (ssp)
<i>Bischoffitilla teuta vicinaria</i> (Mickel, 1934)	Negros	E (ssp)
<i>Bischoffitilla trituberculata</i> (Mickel, 1933)	Taiwan	E
<i>Bischoffitilla tumidula</i> (Mickel, 1934)	Taiwan	
<i>Bischoffitilla umbrosa</i> (Mickel, 1934)	Luzon	E
<i>Bischoffitilla venatrix</i> (Mickel, 1935)	Borneo	E
<i>Blakeius bipunctatus</i> (Latreille, 1792)	Chergui, Corsica	
<i>Blakeius chiesii chiesii</i> (Spinola, 1839)	Asinara, Corsica, Sant'Antioco, Sardinia	E (ssp)
<i>Blakeius chiesii negrei</i> (Suárez, 1958)	Sicily	
<i>Blakeius leopoldinus</i> (Invrea, 1955)	Comino, Gozo, Levanzo, Lipari, Malta, Marettimo, Salina, Sant'Antioco, Sardinia, Sicily, Vulcano	
<i>Cephalotilla suarezi</i> Nonveiller, 1979	Bioko	E
<i>“Ceratotilla” dolosa zanzibarensis</i> (Garcia Mercet, 1903)	Zanzibar	E (ssp)
<i>Ceratotilla</i> sp.	Inhaca	
<i>Chrysotilla analis</i> (Olsoufieff, 1938)	Madagascar	E
<i>Chrysotilla antongilana</i> Bischoff, 1920	Madagascar	E
<i>Chrysotilla chauvini</i> (Olsoufieff, 1938)	Madagascar	E
<i>Chrysotilla consobrina</i> (André, 1901)	Madagascar	E
<i>Chrysotilla elongata</i> (Olsoufieff, 1938)	Madagascar	E
<i>Chrysotilla grandidieri</i> (Saussure, 1890)	Madagascar	E
<i>Chrysotilla honesta</i> (André, 1898)	Madagascar, Nosy Boraha	E
<i>Chrysotilla irradiata</i> (Olsoufieff, 1938)	Madagascar	E
<i>Chrysotilla menavudia</i> (Olsoufieff, 1938)	Madagascar	E
<i>Chrysotilla moerens</i> (André, 1899)	Madagascar	E
<i>Chrysotilla nataliae</i> (Olsoufieff, 1938)	Madagascar	E

Table 2/3. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Chrysotilla pretiosa</i> Bischoff, 1920	Madagascar	E
<i>Chrysotilla saussurei</i> (Olsoufieff, 1938)	Madagascar	E
<i>Chrysotilla sihanaka</i> (Saussure, 1890)	Madagascar	E
<i>Chrysotilla testacea</i> (Olsoufieff, 1938)	Madagascar	E
<i>Chrysotilla vadoni</i> (Olsoufieff, 1938)	Madagascar	E
<i>Chrysotilla variabilis</i> (Olsoufieff, 1938)	Madagascar, Nosy Boraha	E
<i>Ctenotilla porcella</i> (Turner, 1911)	Sri Lanka	
“ <i>Ctenotilla</i> ” <i>spiculata</i> (André, 1908)	Bioko	E
<i>Cystomutilla ruficeps</i> (Smith, 1855)	Corsica, Great Britain, Sardinia, Sicily	
<i>Cystomutilla teranishii</i> Mickel 1935	Hokkaidō, Honshū, Shikoku, Tsushima	
<i>Dasylabris angelae</i> Suárez, 1959	Gran Canaria	E
<i>Dasylabris argentipes</i> (Smith, 1855)	Sri Lanka	
<i>Dasylabris atrata</i> (Linnaeus, 1767)	Lampedusa	
<i>Dasylabris biblica</i> Invrea, 1950	Crete, Cyprus, Rhodes	
<i>Dasylabris canariensis</i> Suárez, 1970	Fuerteventura	E
<i>Dasylabris deckeni signaticeps</i> André, 1906	Koyaama	
<i>Dasylabris deponsa</i> Bischoff, 1921	Madagascar	E
<i>Dasylabris hurei</i> André, 1903	Madagascar	E
<i>Dasylabris juxtarenaria</i> Skorikov, 1935	Djerba, Lampedusa	
<i>Dasylabris manderstiernii cypria</i> (Sichel et Radoszkowski, 1870)	Crete, Cyprus, Gavdos, Rhodes	
<i>Dasylabris maura carinulata</i> (Dalla Torre, 1897)	Asinara, Corsica, Piana dell’Asinara, Santa Maria, San Pietro, Sardinia	E (ssp)
<i>Dasylabris maura maura</i> (Linnaeus, 1758)	Brač, Comino, Euboea, Hvar, Korčula, Krk, Levanzo, Lipari, Malta, Sicily, Syros, Thassos	
<i>Dasylabris porphyrea</i> (Gerstaecker, 1873)	Zanzibar	
<i>Dasylabris rubripilosa</i> Bischoff, 1921	Madagascar	E
<i>Dasylabris rubroaurea</i> (Sichel et Radoszkowski, 1869)	Madagascar	E
<i>Dasylabris rugosa</i> (Olivier, 1811)	Sri Lanka	
<i>Dasylabris scutula</i> Skorikov, 1935	Crete, Gavdos	
<i>Dasylabris seyrigi</i> Olsoufieff, 1938	Madagascar	E
<i>Dasylabris trunciceps</i> Krombein, 1972	Madagascar	E
<i>Dasylabris unipunctata</i> Bischoff, 1921	Inhaca	
<i>Dasylabris voeltzkowi</i> Bischoff, 1921	Madagascar, Nosy Be, Nosy Komba	E
<i>Dasymutilla alesia</i> Banks, 1921	Long Island	
<i>Dasymutilla araneoides</i> (Smith, 1862)	Cañas, Rey	
<i>Dasymutilla asopus bexar</i> (Blake, 1871)	Long Island	
<i>Dasymutilla aureola</i> (Cresson, 1865)	Catalina	
<i>Dasymutilla bioculata</i> (Cresson, 1865)	Padre, Sanibel	
<i>Dasymutilla bouvieri</i> (André, 1898)	Hispaniola	E

Table 2/4. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Dasymutilla californica clio</i> (Blake, 1879)	Vancouver	
<i>Dasymutilla canella</i> (Blake, 1871)	Gardiners, Long Island	
<i>Dasymutilla coccineohirta</i> (Blake, 1871)	Bay Farm, Catalina	
<i>Dasymutilla cypris</i> (Blake, 1871)	Sanibel, St. Simon's	
<i>Dasymutilla gibbosa</i> (Say, 1836)	Fishers, Long Island, Nantucket, Penikese	
<i>Dasymutilla gloriosa</i> (Saussure, 1868)	Matagorda	
<i>Dasymutilla insulana</i> Mickel, 1926	Cuba, Juventud, Little Cayman	E
<i>Dasymutilla interrupta</i> Banks, 1921	Fishers, Long Island	
<i>Dasymutilla lepeletierii</i> (Fox, 1899)	Long Island, Penikese, St. Simon's, Tybee	
<i>Dasymutilla macilenta</i> (Blake, 1871)	Cedar Key, Sanibel	
<i>Dasymutilla macra</i> (Cresson, 1865)	Long Island	
<i>Dasymutilla melancholica</i> (Smith, 1879)	Hispaniola	E
<i>Dasymutilla militaris militaris</i> (Smith, 1855)	Jamaica	E (ssp)
<i>Dasymutilla militaris nigriceps</i> (Cresson, 1865)	Cuba, Great Exuma, Hispaniola, Little Cayman, Martinique	E (ssp)
<i>Dasymutilla mutata</i> (Blake, 1871)	Long Island, St. Simon's	
<i>Dasymutilla nigripes</i> (Fabricius, 1787)	Long Island	
<i>Dasymutilla occidentalis occidentalis</i> (Linnaeus, 1758)	Long Island, St. Simon's	
<i>Dasymutilla quadriguttata</i> (Say, 1823)	Long Island, Nantucket	
<i>Dasymutilla scaevola</i> (Blake, 1871)	Long Island	
<i>Dasymutilla spiniscapula</i> Manley et Pitts, 2007	Hispaniola	E
<i>Dasymutilla vesta</i> (Cresson, 1865)	Cumberland, Long Island, St. Simon's	
<i>Dasymutilla waco</i> (Blake, 1871)	Padre	
<i>Dentilla curtiventris</i> (André, 1901)	Antikythera, Crete, Euboea, Gavdos, Kefalonia, Kythera, Paros, Poros, Rhodes, Sicily, Zakynthos	
<i>Dentilla purcharti</i> Lo Cascio, Romano et Grita, 2012	Samha, Socotra	E
<i>Dentilla socotrana</i> Lo Cascio, Romano et Grita, 2012	Socotra	E
<i>Dolichomutilla sycorax</i> (Smith, 1855)	Fundo, Pemba, Zanzibar	
<i>Eosmicromyrmilla srilankensis</i> Lelej et Krombein, 2001	Sri Lanka	E
<i>Eotrogaspidia amans amans</i> (André, 1909)	Java, Kangean	E (ssp)
<i>Eotrogaspidia auroguttata</i> (Smith, 1855)	Hainan, Okinawa-jima, Taiwan	
<i>Ephucilla bacbo</i> (Lelej, 1996)	Borneo	
<i>Ephucilla drola drola</i> (Zavattari, 1913)	Taiwan	E (ssp)
<i>Ephucilla drupa</i> (Zavattari, 1913)	Taiwan	E
<i>Ephucilla guentheri</i> (Zavattari, 1913)	Taiwan	E
<i>Ephucilla naja</i> (Zavattari, 1913)	Ishigaki-jima, Taiwan	E
<i>Ephucilla poonaensis</i> (Cameron, 1892)	Sri Lanka	
<i>Ephucilla thalia</i> (Mickel, 1933)	Taiwan	E
<i>Ephucilla undata</i> (Chen, 1957)	Taiwan	E
<i>Ephucilla viet</i> (Lelej, 1995)	Dang Kho	(E)

Table 2/5. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Ephucilla yuliana</i> (Tsuneki, 1972)	Taiwan	E
<i>Ephuta cubensis</i> (Blake, 1871)	Cuba	E
<i>Ephuta emarginata</i> Mickel, 1952	Trinidad	
<i>Ephuta festata</i> Mickel, 1928	Cuba	E
<i>Ephuta flavidens</i> Mickel, 1952	Trinidad	
<i>Ephuta furcillata</i> Mickel, 1928	Cuba	E
<i>Ephuta prima</i> Genaro, 1997	Hispaniola	E
<i>Ephuta puteola</i> (Blake, 1879)	Long Island	
<i>Ephuta rubriceps</i> (Cresson, 1865)	Cuba	E
<i>Ephuta singularis</i> (Spinola, 1841)	Cayenne	
<i>Ephuta tholosa</i> Dow, 1931	Cuba	E
<i>Ephuta trinidadensis</i> Ashmead, 1904	Trinidad	E
<i>Ephutomma fletcheri</i> (Turner, 1911)	Sri Lanka	E
<i>Ephutomma montarcense</i> (Garcia Mercet in Giner Mari, 1944)	Mallorca	
“ <i>Ephutomorpha</i> ” <i>aerata</i> (André, 1896)	New Guinea	E
“ <i>Ephutomorpha</i> ” <i>agilis</i> (Smith, 1865)	New Guinea	E
“ <i>Ephutomorpha</i> ” <i>amoenola</i> Turner, 1914	Tasmania	E
“ <i>Ephutomorpha</i> ” <i>australasiae</i> (Fabricius, 1804)	Tasmania	
“ <i>Ephutomorpha</i> ” <i>azurea</i> (Mantero, 1900)	New Guinea	E
“ <i>Ephutomorpha</i> ” <i>biroi</i> André, 1905	New Guinea	E
“ <i>Ephutomorpha</i> ” <i>bivulnerata</i> (André, 1901)	North Island	
“ <i>Ephutomorpha</i> ” <i>blanda</i> (Erichson, 1842)	Tasmania	
“ <i>Ephutomorpha</i> ” <i>concinna</i> (Westwood, 1843)	Tasmania	E
“ <i>Ephutomorpha</i> ” <i>cordatiformis</i> Turner, 1914	Tasmania	E
“ <i>Ephutomorpha</i> ” <i>cyaneiceps</i> André, 1901	Kai	E
“ <i>Ephutomorpha</i> ” <i>damia</i> (Smith, 1863)	Seram	E
“ <i>Ephutomorpha</i> ” <i>dorsigera</i> (Westwood, 1843)	Tasmania	E
“ <i>Ephutomorpha</i> ” <i>elegans</i> (Westwood, 1843)	Tasmania	
“ <i>Ephutomorpha</i> ” <i>extranea</i> (André, 1896)	New Guinea, Yule	E
“ <i>Ephutomorpha</i> ” <i>fausta</i> (Smith, 1863)	Misool	E
“ <i>Ephutomorpha</i> ” <i>fulgida</i> (André, 1896)	New Guinea	E
“ <i>Ephutomorpha</i> ” <i>incisa</i> André, 1905	New Guinea	E
“ <i>Ephutomorpha</i> ” <i>inclyta</i> (André, 1896)	New Guinea	E
“ <i>Ephutomorpha</i> ” <i>lateralis</i> (Westwood, 1843)	Tasmania	E
“ <i>Ephutomorpha</i> ” <i>manteroi</i> Zavattari, 1913	New Guinea	E
“ <i>Ephutomorpha</i> ” <i>melanota</i> (André, 1896)	Morotai	
“ <i>Ephutomorpha</i> ” <i>mirabilis</i> (Smith, 1863)	New Guinea, Waigeo	E
“ <i>Ephutomorpha</i> ” <i>morosa</i> (Westwood, 1843)	Hermite	
“ <i>Ephutomorpha</i> ” <i>notabilis</i> (Smith, 1879)	Tasmania	E

Table 2/6. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>“Ephutomorpha” novoguineana</i> Zavattari, 1913	New Guinea	E
<i>“Ephutomorpha” pagdeni</i> Mickel, 1935	Guadalcanal, Malaita, Pavuvu	E
<i>“Ephutomorpha” pallidipes</i> (André, 1896)	New Guinea	E
<i>“Ephutomorpha” paradisiaca</i> Zavattari, 1913	New Guinea	E
<i>“Ephutomorpha” porrecticeps</i> Turner, 1914	Tasmania	
<i>“Ephutomorpha” postica</i> Turner, 1914	Tasmania	E
<i>“Ephutomorpha” praestans</i> André, 1905	New Guinea	E
<i>“Ephutomorpha” soluta</i> (Erichson, 1841)	Tasmania	E
<i>“Ephutomorpha” splendida</i> (Smith, 1879)	New Guinea	E
<i>“Ephutomorpha” subcristata</i> Turner, 1914	Tasmania	E
<i>“Ephutomorpha” uniformis</i> André, 1903	Tasmania	
<i>“Ephutomorpha”</i> sp.	New Guinea	?
<i>Eurymutilla curta</i> (André, 1896)	Ambon, Buru, New Guinea, Seram, Taliabu	E
<i>Eurymutilla sumbawae</i> (Zavattari, 1913)	Sumbawa	E
<i>Eurymutilla thera</i> (Smith, 1863)	Seram	E
<i>Glossotilla adelpha</i> (André, 1898)	Bioko, São Tomé	
<i>“Glossotilla” atricolor ochraceomaculata</i> (André, 1904)	São Tomé	E (ssp)
<i>Glossotilla illudens</i> Invrea, 1941	Koyaama	(E)
<i>“Glossotilla” luctifera</i> (André, 1903)	São Tomé	
<i>Glossotilla principis</i> (André, 1904)	Príncipe	E
<i>Glossotilla suavis</i> (Gerstaecker, 1871)	Zanzibar	
<i>Hemutilla hoozana</i> (Zavattari, 1913)	Taiwan	
<i>Hildebrandetia hildebrandti</i> (Saussure, 1890)	Madagascar	E
<i>Hoplocrates cephalotes</i> (Swederus, 1787)	Santo Amaro	
<i>Hoplocrates pompalis</i> Mickel, 1941	Trinidad	
<i>Hoplomutilla derasa</i> (Fabricius, 1804)	Cayenne	
<i>Hoplomutilla melana</i> (Spinola, 1841)	Cayenne	
<i>Hoplomutilla opima</i> Mickel, 1939	Trinidad	
<i>Indratilla gynandromorpha</i> Lelej, 1993	Sri Lanka	E
<i>Karlissaidia medvedevi</i> Lelej, 2005	Sri Lanka	E
<i>Karlissaidia turneri</i> Lelej, 2005	Sri Lanka	E
<i>Karunaratnea dilecta</i> (Cameron, 1897)	Sri Lanka	
<i>Karunaratnea palatupanae</i> Lelej, 2005	Sri Lanka	E
<i>Krombeinella beaumonti</i> (Invrea, 1953)	Sicily	
<i>Krombeinella thoracica</i> (Fabricius, 1793)	Corsica, Sant’Antioco, Sardinia	
<i>Krombeinidia albopunctata</i> (André, 1907)	Sri Lanka	E
<i>Krombeinidia bagrada</i> (Cameron, 1902)	Borneo	E
<i>Krombeinidia depressicornis</i> (Mickel, 1935)	Borneo	E
<i>“Krombeinidia” foveata</i> (Cameron, 1900)	Sri Lanka	E

Table 2/7. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Krombeinidia griseomaculata</i> (André, 1898)	Bali, Con Dao, Java, Thao Thu	
<i>Krombeinidia ira ira</i> (Cameron, 1902)	Borneo	
<i>Krombeinidia ira palawana</i> (Mickel, 1934)	Palawan	E (ssp)
<i>Krombeinidia lilliputiana</i> (André, 1894)	Sri Lanka	
<i>Krombeinidia nallinia</i> (Zavattari, 1913)	Bali, Java	E
“ <i>Krombeinidia</i> ” <i>ogлана</i> (Cameron, 1900)	Sri Lanka	
<i>Krombeinidia peterseni</i> Lelej, 1996	Sri Lanka	E
<i>Krombeinidia subfossata</i> (Chen, 1957)	Borneo	
<i>Kudakrumia mirabilis</i> Krombein, 1979	Sri Lanka	E
<i>Kurzenkotilla visrara</i> (Cameron, 1898)	Sri Lanka	E
<i>Labidomilla rufocephala</i> Olsoufieff, 1938	Madagascar	E
<i>Labidomilla tricuspis</i> (André, 1895)	Madagascar	E
<i>Lehritilla lanka</i> Lelej, 2005	Sri Lanka	
<i>Leucospilomutilla cerbera</i> (Klug, 1821)	Cayenne	
<i>Liomutilla canariensis</i> André, 1907	Gomera, Gran Canaria, Hierro, La Palma, Tenerife	E
<i>Lophomutilla triguttata</i> Mickel, 1952	Trinidad	
<i>Macromyrme bezdeki</i> Lo Cascio, Romano et Grita, 2012	Socotra	E
<i>Macromyrme sinuata</i> (Olivier, 1811)	Cyprus	
<i>Mickelomyrme aborlana aborlana</i> (Tsuneki, 1993)	Palawan	E (ssp)
<i>Mickelomyrme aborlana zamboangae</i> (Tsuneki, 1993)	Mindanao	E (ssp)
<i>Mickelomyrme bakeri</i> (Mickel, 1934)	Balabac, Labuan, Palawan	E
<i>Mickelomyrme bicristata</i> (Chen, 1957)	Hainan	E
<i>Mickelomyrme bidentata</i> (Tsuneki, 1993)	Luzon	
<i>Mickelomyrme hageni</i> (Zavattari, 1913)	Iriomote-jima, Ishigaki-jima, Okinawa-jima, Taiwan; Hachijō-jima	
<i>Mickelomyrme ilanica</i> (Tsuneki, 1972)	Taiwan	E
<i>Mickelomyrme norna</i> (Zavattari, 1913)	Taiwan	E
<i>Mickelomyrme palawanensis</i> (Mickel, 1934)	Palawan	E
<i>Mickelomyrme semperi nigrogastra</i> (Mickel, 1934)	Luzon, Palawan	E (ssp)
<i>Mickelomyrme semperi semperi</i> (Ashmead, 1904)	Luzon, Negros, Panay	E (ssp)
<i>Mickelomyrme tanoi</i> (Tsuneki, 1972)	Borneo	E
<i>Mickelomyrme zebina</i> (Smith, 1860)	Borneo, Cebu, Luzon, Mactan, Mindanao, Negros, Bacan	E
<i>Mutilla alticola</i> (André, 1904)	São Tomé	E
“ <i>Mutilla</i> ” <i>antiguensis</i> Fabricius, 1775	Antigua	
<i>Mutilla astarte astarte</i> Smith, 1855	Mafia	
<i>Mutilla astarte orientalis</i> Bischoff, 1920	Zanzibar	
<i>Mutilla auriger</i> Krombein, 1951	Madagascar	E
<i>Mutilla berlandi</i> Krombein, 1972	Madagascar	E

Table 2/8. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Mutilla bilunata</i> (Gerstaecker, 1857)	Zanzibar	
<i>Mutilla dentidorsis</i> André, 1908	Zanzibar	
<i>Mutilla diselena</i> s.l. Sichel et Radoszkowski, 1870	Pemba	
<i>Mutilla diselena germanica</i> Bischoff, 1920	Zanzibar	
<i>Mutilla europaea</i> Linnaeus, 1758	Great Britain, Norderney, Sicily, Wangerooge	
<i>Mutilla mikado</i> Cameron, 1900	Hokkaidō, Honshū, Jeju, Kyūshū, Sakhalin, Shikoku	
“ <i>Mutilla</i> ” <i>oberthuri</i> André, 1907	Zanzibar	
“ <i>Mutilla</i> ” <i>pygidialis</i> Gerstaecker, 1871	Zanzibar	E
<i>Mutilla quinquemaculata</i> Cyrillus, 1787	Astypalea, Budelli, Cavallo, Čiovo, Corsica, Crete, Cyprus, Elba, Euboea, Gavdos, Kassos, Kefalonia, La Maddalena, Lampedusa, Mallorca, Malta, Menorca, Pianosa, Rhodes, Sant’Antioco, Sardinia, Sicily	
<i>Mutilla scabrofoveolata</i> Sichel et Radoszkowski, 1869	Inhaca	
“ <i>Mutilla</i> ” <i>straba</i> Gerstaecker, 1871	Zanzibar	
“ <i>Mutilla</i> ” sp. 1	Zanzibar	E?
“ <i>Mutilla</i> ” sp. 2	Anak Krakatau, Panaitan, Peucang, Rakata Besar, Rakata Kecil, Sertung	
<i>Myrmilla calva</i> (Villiers, 1789)	Asinara, Brač, Corsica, Crete, Elba, Giglio, Gorgona, Gran Canaria, Kerkyra, Korčula, La Maddalena, Lipari, Mallorca, Pianosa, Rhodes, Sant’Antioco, Sardinia, Sicily, Ustica, Vis, Vulcano	
<i>Myrmilla capitata</i> (Lucas, 1846)	Asinara, Corsica, Favignana, La Maddalena, Lampedusa, Levanzo, Pianosa, Sant’Antioco, San Pietro, Sardinia, Sicily, Syros	
<i>Myrmilla caucasica</i> (Kolenati, 1846)	Cyprus, Kos, Nisyros, Rhodes	
<i>Myrmilla corniculata</i> (Sichel et Radoszkowski, 1869)	Kerkyra, Skopelos, Syros, Tinos	
<i>Myrmilla erythrocephala</i> (Latreille, 1792)	Brač, Corsica, Giglio, Hvar, Korčula, La Maddalena, Sardinia, Sicily, Ugljan, Vis	
<i>Myrmilla georgiae</i> Pagliano et Matteini Palmerini, 2014	Djerba, Gataya el Bahria	
<i>Myrmilla glabrata</i> (Fabricius, 1775)	Cyprus, Euboea, Kerkyra, Pano Koufonissi, Skyros, Syros	
<i>Myrmilla lezginica</i> (Radoszkowski, 1885)	Cyprus	
<i>Myrmilla mavromoustakisi</i> Hammer, 1950	Cyprus	E
<i>Myrmilla mutica</i> (André, 1903)	Crete, Hvar, Kefalonia, Kerkyra	
<i>Myrmilla troodosica</i> Hammer, 1950	Cyprus	E
<i>Myrmilla vutshetishi</i> Skorikov, 1927	Chios, Kerkyra	
<i>Myrmilla</i> sp.	Socotra	
<i>Myrmosa atra atra</i> Panzer, 1801	Anglesey, Corsica, Elba, Great Britain, Man, Sardinia, Sicily, Wight	
<i>Myrmosa atra erythrocephala</i> Yarrow, 1954	Ireland	E (ssp)
<i>Myrmosa eos</i> Lelej, 1981	Jeju, Namhae	
<i>Myrmosa unicolor</i> Say, 1824	“High Island” (= unidentified islet of Outer Banks)	
<i>Nanomutilla vaucheri</i> (Tournier, 1895)	Sardinia	
<i>Nemka chihpenchia</i> (Tsuneki, 1972)	Taiwan	E

Table 2/9. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Nemka curvisquamata</i> (Chen, 1957)	Taiwan	E
“ <i>Nemka</i> ” <i>fallaciosa</i> (Cameron, 1898)	Sri Lanka	E
<i>Nemka limi nanhai</i> (Chen, 1957)	Hainan	E (ssp)
“ <i>Nemka</i> ” <i>litigiosa</i> (Cameron, 1898)	Sri Lanka	E
<i>Nemka</i> cfr. <i>philippa</i> (Nurse, 1903)	Peucang, Rakata Kecil, Sertung	
<i>Nemka pondicherensis</i> (Sichel et Radoszkowski, 1870)	Luzon, Sri Lanka, Timor	
“ <i>Nemka</i> ” <i>stulta</i> (Cameron, 1898)	Sri Lanka	E
<i>Nemka taiwanensis</i> (Mickel, 1933)	Taiwan	
<i>Nemka viduata insulae</i> (Invrea, 1940)	Cyprus	E (ssp)
<i>Nemka viduata macquarti</i> (Lepeletier, 1845)	Crete, Gavdos	E (ssp)
<i>Nemka viduata tunensis</i> (Fabricius, 1804)	Jalitah	
<i>Nemka viduata viduata</i> (Pallas, 1773)	Brač, Comino, Corsica, Elba, Euboea, Favignana, Giglio, Gozo, Karpathos, Kea, Kefalonia, Kerkyra, Korkula, Kos, Kythera, Lipari, Mallorca, Malta, Marettimo, Menorca, Naxos, Pano Koufonissi, Pianosa, Rhodes, Samothraki, San Pietro, Sardinia, Sicily, Skiathos, Stromboli, Vis, Vulcano	
<i>Nemka wotani</i> (Zavattari, 1913)	Magong, Sumbawa, Taiwan, Tanegashima, Yakushima; Honshū, Kyūshū	
<i>Neotrogaspidia haemarrhoa</i> (Zavattari, 1913)	Lombok, Sumbawa	E
<i>Neotrogaspidia hammeri</i> (Suárez, 1959)	Cyprus	
<i>Neotrogaspidia pustulata</i> (Smith, 1873)	Amami Ōshima, Iwo-jima, Miyakojima, Taiwan, Takeshima, Tanegashima, Yakushima, Hachijōjima, Honshū, Izu Ōshima, Jeju, Kyūshū, Namhae, Shikoku, Shimoshima, Tsushima, Chichi-jima, Nishi-jima	
<i>Neotrogaspidia serafica</i> (Zavattari, 1913)	Lombok, Solor, Sumbawa; Ambon	E
<i>Nonveilleridia bataviana</i> (André, 1909)	Java	
<i>Nordeniella pinguicula</i> (Turner, 1911)	Sri Lanka	E
<i>Nordeniella praestabilis</i> (André, 1907)	Sri Lanka	E
<i>Nordeniella thermophila</i> (Turner, 1911)	Sri Lanka	E
<i>Nordeniella wickwari</i> (Turner, 1911)	Sri Lanka	E
<i>Odontomutilla apiastra</i> Mickel, 1935	Bacan, Halmahera	E
<i>Odontomutilla aspratilis</i> Mickel, 1935	Borneo	
<i>Odontomutilla ceramensis</i> Mickel, 1935	Seram	E
<i>Odontomutilla cordigera</i> (Sichel et Radoszkowski, 1870)	Borneo, Java, Sumatra	
<i>Odontomutilla disparimaculata</i> (Sichel et Radoszkowski, 1869)	São Tomé	
<i>Odontomutilla familiaris anonyma</i> (Kohl, 1882)	Sumatra	E (ssp)
<i>Odontomutilla familiaris familiaris</i> (Smith, 1857)	Basilan, Borneo, Luzon, Mindanao, Negros, Samar, Singapore, Sumatra	
<i>Odontomutilla grossa</i> Mickel, 1935	Borneo	E
<i>Odontomutilla haematocephala</i> (André, 1896)	Sumatra	
<i>Odontomutilla herpa</i> (Cameron, 1902)	Borneo	E

Table 2/10. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Odontomutilla inanis</i> Mickel, 1935	Daru, New Britain, New Guinea	E
<i>Odontomutilla manifesta</i> (Smith, 1859)	New Guinea, Tanahbesar	E
<i>Odontomutilla mickeli</i> Lelej, 2005	Borneo, Sulawesi	E
<i>Odontomutilla papuana</i> Zavattari, 1913	New Guinea	E
<i>Odontomutilla perelegans</i> (Cameron, 1897)	Sri Lanka	
<i>Odontomutilla pompalis</i> Mickel, 1935	Borneo	E
<i>Odontomutilla rubrocapitata</i> Mickel, 1935	Borneo	
<i>Odontomutilla semifasciata</i> (André, 1896)	Solor, Sulawesi; New Guinea	E
<i>Odontomutilla smithi</i> Mickel, 1935	Sulawesi	E
<i>Odontomutilla subinterrupta</i> Zavattari, 1910	Borneo, Java, Simeulue, Timor	E
<i>Odontomutilla tamensis</i> (Cameron, 1907)	New Guinea	E
<i>Odontomutilla thymele</i> Mickel, 1935	Borneo	E
<i>Odontomutilla trichocondyla</i> (André, 1894)	Sri Lanka	
<i>Odontomutilla zimrada maxima</i> Bischoff, 1920	Zanzibar	
<i>Orientidia cavicola</i> (Tsuneki, 1993)	Mindanao	E
<i>Orientidia circumcincta</i> (André, 1896)	Sumatra	
<i>Orientidia dayak</i> (Lelej, 1996)	Borneo	E
<i>Orientidia nigerrima</i> (Mickel, 1934)	Biliran, Luzon, Mindanao, Samar	E
<i>Orientidia proserpina proserpina</i> (Smith, 1857)	Basilan, Borneo, Java, Mindanao, Negros, Panay	E (ssp)
<i>Orientidia proserpina sibuyanensis</i> (Mickel, 1934)	Sibuyan	E (ssp)
<i>Orientidia proserpina tibiata</i> (Mickel, 1934)	Basilan, Borneo, Mindanao, Negros, Palawan, Sibuyan	E (ssp)
<i>Orientilla aureorubra</i> (Sichel et Radoszkowski, 1870)	Sri Lanka	
<i>Orientilla desponsa</i> (Smith, 1855)	Hainan, Taiwan	
<i>Orientilla kallata</i> (Nurse, 1902)	Sri Lanka	
<i>Orientilla remota</i> (Cameron, 1897)	Sri Lanka	E
<i>Pagdenidia erato</i> (Mickel, 1935)	Borneo	E
<i>Pagdenidia selene</i> (Pagden, 1949)	Java	E
<i>Pagdenidia sondaica</i> (Pagden, 1949)	Java	E
<i>Paramyrmosa brunnipes</i> (Lepeletier, 1845)	Asinara, Corsica, Crete, Mallorca, Rhodes, Sardinia, Sicily	
<i>Pertyella decora</i> Mickel, 1952	Trinidad	
“ <i>Petersenidia</i> ” <i>boopis</i> (Kohl, 1882)	Sulawesi	E
<i>Petersenidia dercetis</i> (Mickel, 1935)	Borneo	E
“ <i>Petersenidia</i> ” <i>dohertyi</i> (Zavattari, 1913)	Sumbawa	E
<i>Petersenidia fukudai</i> (Tsuneki, 1972)	Amami Ōshima, Kakeromajima, Okinawa-jima, Tokunoshima, Yakushima, Kyūshū, Shikoku	E
<i>Petersenidia hylonome</i> (Mickel, 1935)	Borneo	E
<i>Petersenidia javanica</i> (Dalla Torre, 1897)	Java	E
<i>Petersenidia macassarica</i> (Zavattari, 1913)	Sulawesi	E

Table 2/11. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Petersenidia nedyme</i> (Mickel, 1935)	Borneo	E
<i>Petersenidia neglecta</i> (Smith, 1860)	Sulawesi	E
<i>Petersenidia olbia</i> (Cameron, 1902)	Borneo	E
<i>Petersenidia pfafneri</i> (Zavattari, 1913)	Taiwan	E
<i>Petersenidia psecas</i> (Mickel, 1935)	Borneo	E
<i>Petersenidia rapa</i> (Zavattari, 1913)	Okinawa-jima, Taiwan	
<i>Petersenidia spatale</i> (Mickel, 1935)	Borneo	E
<i>Petersenidia spiracularis dilutemacula</i> (Chen, 1957)	Taiwan	E (ssp)
<i>Petersenidia stella</i> (Zavattari, 1913)	Sumatra	E
<i>Petersenidia sticticornis nigridia</i> (Mickel, 1934)	Mindanao, Samar	E (ssp)
<i>Petersenidia sticticornis sticticornis</i> (Mickel, 1934)	Mindanao, Samar	E (ssp)
<i>Petersenidia sumatrensis</i> (André, 1896)	Sumatra	E
<i>Petersenidia temeraria</i> (Mickel, 1934)	Luzon	E
<i>Petersenidia thoracica</i> (Smith, 1860)	Sulawesi	E
<i>Physetopoda cingulata</i> (Costa, 1858)	Corsica	
<i>Physetopoda consociata</i> (Cameron, 1898)	Sri Lanka	E
<i>Physetopoda daghestanica</i> (Radoszkowski, 1885)	Corsica, Krk, Mallorca, Sicily	
<i>Physetopoda fumigata</i> (Turner, 1911)	Sri Lanka	E
<i>Physetopoda fusculina</i> (Invrea, 1955)	Lavezzu, Sant'Antioco, San Pietro, Sardinia	E
<i>Physetopoda halensis</i> (Fabricius, 1787)	Bagaud, Krk, Malta, Rab, Sicily	
<i>Physetopoda lampedusia</i> (Invrea, 1957)	Gremdi, Lampedusa, Mallorca, Sicily	
<i>Physetopoda ligustica</i> (Invrea, 1951)	Mallorca, Malta, Sicily	
<i>Physetopoda lucasii</i> (Smith, 1855)	Corsica, Elba, Pantelleria, Pianosa, Sardinia, Sicily, Ustica	
<i>Physetopoda mendizabali</i> (Suárez, 1956)	Asinara, Sardinia	
<i>Physetopoda mirabilis</i> (Hammer, 1962)	Sri Lanka	
<i>Physetopoda nuptura</i> (Garcia Mercet, 1905)	Malta, Sicily	
<i>Physetopoda punctata</i> (Latreille, 1792)	Comino, Corsica, Lampedusa, Linosa, Malta, Sardinia, Sicily	
<i>Physetopoda pusilla</i> (Klug, 1835)	Asinara, Corsica, Elba, Gorgona, Lampedusa, Levanzo, Lipari, Mallorca, Malta, Pianosa, Sardinia, Sicily, Vis	
<i>Physetopoda scutellaris</i> (Latreille, 1792)	Corsica, Krk, Pianosa, Sicily	
<i>Physetopoda sericeiceps</i> (André, 1901)	Asinara, Corsica, Mallorca, Sant'Antioco, Sardinia	
<i>Physetopoda silviae</i> Pagliano, 2011	Lampedusa	E
<i>Physetopoda trioma</i> (Invrea, 1955)	Asinara, Corsica, Lavezzu, Sant'Antioco, Sardinia	E
<i>Physetopoda uncinata</i> (Lucas, 1846)	Malta, Menorca	
<i>Platymyrmilla quinquefasciata</i> (Olivier, 1811)	Andros, Crete, Karpathos, Kerkyra, Rhodes, Syros	
<i>Pristomutilla ianthis</i> (Turner, 1911)	Sri Lanka	
<i>Pristomutilla kibweziana</i> Bischoff, 1920	Zanzibar	
<i>Pristomutilla octacantha</i> (Garcia Mercet, 1903)	Bioko	

Table 2/12. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Pristomutilla pauliani</i> (Krombein, 1951)	Madagascar	E
<i>Promecidia bonthainensis</i> (André, 1896)	Sulawesi	E
<i>Promecidia mamblia</i> (Cameron, 1902)	Borneo	
<i>Promecidia rubrocyanea</i> (Mickel, 1935)	Borneo	E
<i>Promecidia saturnia samawangensis</i> (Mickel, 1935)	Borneo	E (ssp)
<i>Promecidia saturnia saturnia</i> (Mickel, 1935)	Singapore	
<i>Promecidia yamanei</i> Lelej, 1996	Borneo	E
<i>Promecilla calliope</i> (Smith, 1857)	Borneo	E
<i>Promecilla cyanosoma</i> Turner, 1911	Sri Lanka	E
<i>Promecilla delia</i> (Mickel, 1935)	Borneo	E
<i>Promecilla hyale</i> (Mickel, 1934)	Mindanao	E
<i>Promecilla philippinensis</i> Lelej, 2005	Luzon, Mindanao	E
<i>Promecilla yerburghi</i> (Cameron, 1892)	Sri Lanka	
<i>Protrogaspidia celebensis</i> (André, 1905)	Sulawesi	E
<i>Protrogaspidia volatilis</i> (Smith, 1858)	Sulawesi	E
<i>Pseudolophotilla alluaudi</i> (André, 1907)	Madagascar	E
<i>Pseudolophotilla argenteopicta</i> (Sichel et Radoszkowski, 1869)	Madagascar	E
<i>Pseudolophotilla venustula</i> (Saussure, 1890)	Madagascar, Nosy Be	E
<i>Pseudomethoca argyrocephala</i> (Gerstaecker, 1874)	Cuba, Guana, Puerto Rico, St. John	
<i>Pseudomethoca</i> cf. <i>tournieri</i> (Kohl, 1882)	Trinidad	
<i>Pseudomethoca crepera</i> (Cresson, 1902)	Trinidad	
<i>Pseudomethoca flaviceps</i> (André, 1906)	Hispaniola	E
<i>Pseudomethoca grilloi</i> Genaro, 1997	Cuba	E
<i>Pseudomethoca merengue</i> Genaro, 1997	Hispaniola	E
<i>Pseudomethoca olgae</i> Schuster, 1946	St. Croix	E
<i>Pseudomethoca plagiata</i> (Gerstaecker, 1874)	Trinidad	
<i>Pseudomethoca propinqua</i> (Cresson, 1865)	Long Island	
<i>Pseudomethoca salti</i> Mickel, 1928	Cuba	E
<i>Pseudomethoca simillima</i> (Smith, 1855)	Long Island	
<i>Pseudomethoca uncinata</i> Ashmead, 1900	St. Vincent	E
<i>Pseudomethoca willei</i> Mickel, 1969	Cañas, Coiba, Taboga	
<i>Pseudophotopsis armeniaca</i> (Skorikov, 1935)	Cyprus	
<i>Pseudophotopsis aurea</i> (Klug, 1829)	Socotra	
<i>Pseudophotopsis komarovii</i> (Radoszkowski, 1885)	Cyprus	
<i>Pseudophotopsis maura</i> Bischoff, 1920	Socotra	
<i>Pseudophotopsis obliterated</i> (Smith, 1855)	Cyprus	
<i>Pseudophotopsis schachruda</i> (Skorikov, 1935)	Cyprus	
<i>Pseudophotopsis syriaca</i> (André, 1900)	Tinos	

Table 2/13. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Radoszkowskitilla ceylonica</i> (Lelej, 1993)	Sri Lanka	
<i>Radoszkowskitilla sinhala</i> Lelej, 2005	Sri Lanka	E
<i>Radoszkowskitilla tamila</i> Lelej, 2005	Sri Lanka	E
<i>Rhopalomutilla javana</i> Pagden, 1938	Java	E
<i>Rhopalomutilla oceanica</i> Mickel, 1935	Borneo	E
<i>Ronisia barbara</i> (Linnaeus, 1758)	Comino, Conigli, Gozo, Lampedusa, Linosa, Malta, Pantelleria	
<i>Ronisia barbarula</i> (Petersen, 1988)	Mallorca	
<i>Ronisia brutia brutia</i> (Petagna, 1787)	Capraia, Capri, Corsica, Elba, Euboea, Favignana, Filicudi, Folegandros, Giannutri, Giglio, Gorgona, Hvar, Ischia, Kastellorizo, Kefalonia, Kerkyra, Korčula, Krk, Kythera, La Maddalena, Lavezzi, Levanzo, Lipari, Malta, Marettimo, Milos, Naxos, Panarea, Paros, Pianosa, Rhodes, Salina, San Domino, Sant'Antioco, Sardinia, Sicily, Skiathos, Syros, Thira, Ugljan, Vis, Vulcano, Zakynthos	
<i>Ronisia brutia minoensis</i> Nonveiller, 1972	Astypalea, Crete, Karpathos	E (ssp)
<i>Ronisia brutia valca</i> (Petersen, 1988)	Cyprus	E (ssp)
<i>Ronisia ghilianii</i> (Spinola, 1843)	Asinara, Capraia, Corsica, Gorgona, La Maddalena, Lipari, Mallorca, Menorca, Panarea, Pianosa, Sant'Antioco, Santa Maria, San Pietro, Sardinia, Sicily, Spargi	
<i>Ronisia marocana</i> (Olivier, 1811)	Djerba, Lampedusa, Malta, Sicily	
<i>Serendibiella trunconomalia</i> (Radoszkowski, 1885)	Sri Lanka	E
<i>Seriatospidia biseriata</i> (Saussure, 1891)	Zanzibar	
<i>Seyrigilla cloitrei</i> (Olsoufieff, 1938)	Madagascar	E
<i>Seyrigilla holomelaena</i> (André, 1899)	Madagascar	E
<i>Seyrigilla nigroaurea</i> (Sichel et Radoszkowski, 1869)	Madagascar, Nosy Be	E
<i>Seyrigilla olsoufieffi</i> (Krombein, 1972)	Madagascar	E
<i>Seyrigilla splendida</i> (Olsoufieff, 1938)	Madagascar	E
<i>Seyrigilla sylvicola</i> (Krombein, 1972)	Madagascar	E
<i>Sigilla dorsata</i> (Fabricius, 1798)	Corsica, Embiez, Porquerolles, Sant'Antioco, Sardinia	
<i>Sinotilla gracillima</i> (Smith, 1857)	Borneo	E
<i>Sinotilla gribodoana</i> (Invrea, 1943)	Borneo	E
<i>Sinotilla lambirensis</i> Lelej, 1996	Borneo	E
<i>Sinotilla petina</i> (Mickel, 1937)	Borneo	E
<i>Sinotilla runcina</i> (Zavattari, 1913)	Borneo	E
<i>Sinotilla serpa</i> (Zavattari, 1913)	Taiwan	E
<i>Sinotilla yakushimensis</i> (Yasumatsu, 1934)	Yakushima	E
“ <i>Smicromyrme</i> ” <i>adusta</i> (André, 1908)	Zanzibar	E
<i>Smicromyrme aponis</i> Tsuneki, 1993	Mindanao	E
<i>Smicromyrme asinarensis</i> Pagliano et Strumia, 2007	Asinara, Sardinia	E

Table 2/14. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Smicromyrme ausonia</i> Invrea, 1950	Asinara, Corsica, Cyprus, Elba, Kerkyra, Lipari, Pianosa, Sicily	
<i>Smicromyrme autonoe</i> Mickel, 1934	Palawan	E
<i>Smicromyrme basalis annularis</i> Mickel, 1934	Luzon	E (ssp)
<i>Smicromyrme basalis basalis</i> (Smith, 1879)	Borneo, Mindanao	E (ssp)
<i>Smicromyrme borneo</i> Lelej, 1996	Borneo	E
<i>Smicromyrme caecina</i> (Cameron, 1903)	Borneo	E
<i>Smicromyrme caerulea</i> Mickel, 1934	Samar	E
<i>Smicromyrme calacuasana</i> Tsuneki, 1993	Palawan	E
<i>Smicromyrme chuchiana</i> Tsuneki, 1993	Taiwan	E
<i>Smicromyrme coromandelica</i> (Motschulsky, 1863)	Sri Lanka	
<i>Smicromyrme corriasi</i> Pagliano, 2013	Sardinia	E
<i>Smicromyrme cristinae</i> Lo Cascio, 2000	Pano Koufonissi	E
<i>Smicromyrme dardanus dardanus</i> (Smith, 1857)	Borneo	
<i>Smicromyrme dardanus salacia</i> Mickel, 1935	Borneo	E (ssp)
<i>Smicromyrme deidamia</i> (Smith, 1857)	Borneo	E
<i>Smicromyrme desiderata</i> (Turner, 1911)	Sri Lanka	E
<i>Smicromyrme devia</i> (Cameron, 1909)	Borneo, Simeulue	E
<i>Smicromyrme electra</i> Mickel, 1935	Sulawesi	E
<i>Smicromyrme esterina</i> Pagliano, 1983	Sicily	
<i>Smicromyrme fura anthracipes</i> Mickel, 1934	Luzon	E (ssp)
<i>Smicromyrme fura fura</i> Mickel, 1934	Basilan, Luzon, Mindanao, Negros, Panay, Samar, Sibuyan	E (ssp)
<i>Smicromyrme gineri</i> Invrea, 1953	Djerba	
<i>Smicromyrme herophile</i> Mickel, 1935	Java	E
<i>Smicromyrme hombucciana</i> Tsuneki, 1982	Taiwan	E
<i>Smicromyrme ilerda ilerda</i> (Cameron, 1902)	Borneo	E (ssp)
<i>Smicromyrme ilerda sparsilis</i> Mickel, 1934	Mindanao	E (ssp)
<i>Smicromyrme jacobsoni</i> (André, 1907)	Java	E
<i>Smicromyrme kuanfuana</i> Tsuneki, 1972	Taiwan	E
<i>Smicromyrme lavinia atrata</i> Mickel, 1934	Samar	E (ssp)
<i>Smicromyrme lavinia lavinia</i> Mickel, 1934	Luzon, Mindanao, Palawan	E (ssp)
<i>Smicromyrme lewisi</i> Mickel, 1935	Iwo-jima, Kuchinoshima, Tanegashima, Hokkaidō, Honshū, Izu Ōshima, Kunashir, Kyūshū, Namhae, Okushiri, Sakhalin, Shikoku, Tsushima	
<i>Smicromyrme lochia</i> Mickel, 1937	Borneo	
<i>Smicromyrme maculofasciata</i> (Saussure, 1867)	Sri Lanka	E
<i>Smicromyrme mauromoustakisi</i> Invrea, 1940	Cyprus	E
<i>Smicromyrme meator</i> Mickel, 1935	Borneo	E
<i>Smicromyrme melanolepis</i> (Costa, 1884)	Asinara, Corsica, Gorgona, Lipari, Marettimo, Sardinia, Sicily	

Table 2/15. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Smicromyrme minahassae</i> (Zavattari, 1913)	Sulawesi	E
<i>Smicromyrme mindanaonis</i> Tsuneki, 1993	Mindanao	E
<i>Smicromyrme monticelli</i> (Zavattari, 1910)	Zanzibar	
<i>Smicromyrme neglecta</i> Hammer, 1962	Sri Lanka	
<i>Smicromyrme nigriceps</i> Nonveiller, 1959	Crete, Gavdos	
<i>Smicromyrme ocellata</i> (Saussure, 1867)	Sri Lanka	
<i>Smicromyrme opistomelas</i> Invrea, 1950	Sardinia	
<i>Smicromyrme palacala</i> Tsuneki, 1993	Palawan	E
<i>Smicromyrme partita</i> (Klug, 1835) sensu lato	Comino, Lampedusa, Lipari, Mallorca, Malta, Sicily	
<i>Smicromyrme perisii</i> (Sichel et Radoszkowski, 1870)	Asinara, Cavallo, Corsica, Sant'Antioco, Sardinia	E
<i>Smicromyrme posthuma</i> (Cameron, 1898)	Sri Lanka	E
<i>Smicromyrme pulawskii</i> Suárez, 1975	Rhodes	
<i>Smicromyrme punctinota</i> Mickel, 1935	Borneo	E
<i>Smicromyrme riccardoi</i> Pagliano et Matteini Palmerini, 2014	Djerba	
<i>Smicromyrme ruficollis cerasae</i> Invrea, 1952	Asinara, Corsica, San Pietro, Sant'Antioco, Sardinia	E (ssp)
<i>Smicromyrme ruficollis ruficollis</i> (Fabricius, 1793)	Cres, Giglio, Gozo, Hvar, Kos, Krk, Lipari, Mallorca, Malta, Pianosa, Rab, Sicily, Stromboli, Vulcano	
<i>Smicromyrme rufipes</i> (Fabricius, 1787)	Baltrum, Corsica, Giglio, Great Britain, Hayling, Herm, Hvar, Krk, Pianosa, Wight	
<i>Smicromyrme rufisquamulata</i> Bischoff, 1921	Inhaca	
<i>Smicromyrme scitula</i> Mickel, 1935	Borneo	E
<i>Smicromyrme sexmaculata</i> Hammer, 1962	Sri Lanka	
<i>Smicromyrme sicana</i> (De Stefani, 1887)	Corsica, Elba, Kornat, Krk, Malta, Pianosa, Sardinia, Sicily	
<i>Smicromyrme strandi</i> (Zavattari, 1913)	Taiwan	
<i>Smicromyrme suberrata</i> Invrea, 1957	Asinara, Lampedusa, Mallorca, Malta, Sicily	
<i>Smicromyrme sulcisia</i> Invrea, 1955	Corsica, Elba, Lipari, Mallorca, Sardinia, Sicily, Vulcano	
<i>Smicromyrme thia</i> Mickel, 1933	Taiwan	E
<i>Smicromyrme trinotata</i> (Costa, 1858)	Corsica, Lipari, Sardinia, Sicily	
<i>Smicromyrme turanica</i> (Morawitz, 1893)	Crete, Rhodes	
<i>Smicromyrme vladani</i> Nonveiller, 1972	Crete	E
<i>Smicromyrme</i> sp. 1	Gran Canaria	
<i>Smicromyrme</i> sp. 2	Korčula, Vis	
“ <i>Smicromyrme</i> ” sp. 3	Inhaca	
<i>Sphaerophthalma cargilli</i> Cockerell, 1895	Jamaica	E
<i>Sphaerophthalma galapagensis</i> (Williams, 1926)	Baltra, Santa Cruz (EC)	E
<i>Sphaerophthalma gulltopp</i> Williams et Pitts, 2007	Trinidad	
<i>Sphaerophthalma retifera</i> (Dow, 1931)	Hispaniola	

Table 2/16. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Sphaerophthalma unicolor</i> (Cresson, 1865)	Anacapa, Santa Cruz (US)	
<i>Spilomutilla consolidata</i> (Cameron, 1900)	Sri Lanka	
<i>Spilomutilla eltola</i> (Cameron, 1898)	Sri Lanka	E
<i>Spilomutilla lanka</i> Lelej, 2005	Sri Lanka	E
<i>Spilomutilla sri</i> Lelej, 2005	Sri Lanka	E
<i>Squamulotilla exilipunctata</i> Chen, 1957	Jeju	
<i>Standfussidia taprobane</i> Lelej, 2005	Sri Lanka	E
<i>Stenomutilla argentata</i> (Villers, 1789)	Asinara, Corsica, Sant'Antioco, San Pietro, Sardinia, Sicily	
<i>Stenomutilla bicornuta</i> Nonveiller, 1994	Cyprus	E
<i>Stenomutilla bizonata</i> (Smith, 1855)	Euboea, Hvar, Rhodes	
<i>Stenomutilla collaris</i> (Fabricius, 1787)	Djerba, Sicily	
<i>Stenomutilla freyi</i> (Brancsik, 1891)	Madagascar, Nosy Be	E
<i>Stenomutilla hottentotta</i> (Fabricius, 1804)	Comino, Favignana, Gozo, Levanzo, Malta, Marettimo, Sicily	
<i>Stenomutilla intermixta</i> Krombein, 1972	Madagascar	E
<i>Stenomutilla lavaudeni ambilobe</i> Krombein, 1972	Madagascar	E (ssp)
<i>Stenomutilla lavaudeni lavaudeni</i> Olsoufieff, 1938	Madagascar	E (ssp)
" <i>Stenomutilla</i> " <i>manni</i> Krombein, 1971	Makira	E
<i>Storozhenkotilla aurofasciata</i> (André, 1907)	Sri Lanka	
<i>Storozhenkotilla cicatricifera</i> (André, 1894)	Sri Lanka	
<i>Strangulotilla dioscoridea</i> Lo Cascio, Romano et Grita, 2012	Samha, Socotra	E
<i>Strangulotilla krombeini</i> Lelej, 2005	Sri Lanka	E
<i>Strangulotilla minor</i> (André, 1905)	São Tomé	E
<i>Sylvotilla globithorax</i> (Olsoufieff, 1938)	Madagascar	E
<i>Sylvotilla globiventris</i> (Olsoufieff, 1938)	Madagascar	E
<i>Sylvotilla robinsoni</i> (Olsoufieff, 1938)	Madagascar	E
<i>Sylvotilla touvenoti</i> (Olsoufieff, 1938)	Madagascar	E
<i>Taimyrmosa cara</i> Lelej, 2005	Taiwan	E
<i>Taimyrmosa mongolica</i> (Suárez, 1974)	Honshū, Jeju, Sakhalin, Shikoku	
<i>Taimyrmosa nigrofasciata</i> (Yasumatsu, 1931)	Yakushima, Hokkaidō, Honshū, Kyūshū, Okushiri, Shikoku	E
<i>Taiwanomyrme friekae</i> (Zavattari, 1913)	Taiwan	
<i>Taiwanomyrme taiwana</i> (Tsuneki, 1993)	Taiwan	E
<i>Timulla absentia</i> Mickel, 1938	Cañas, Rey	
<i>Timulla ashmeadi</i> Mickel, 1938	Grenada, Guadeloupe, Jamaica, St. Vincent	E
<i>Timulla bitaeniata</i> (Spinola, 1841)	Cayenne, Trinidad	
<i>Timulla byblis</i> Mickel, 1937	Trinidad	
<i>Timulla centroamericana</i> (Dalla Torre, 1897)	Taboga	
<i>Timulla dominica</i> Mickel, 1938	Dominica	E

Table 2/17. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Timulla eriphyla</i> Mickel, 1938	Trinidad	
<i>Timulla ferrugata</i> (Fabricius, 1804)	Long Island; Eleuthera	
<i>Timulla guadeloupensis</i> Mickel, 1937	Guadeloupe	E
<i>Timulla leona</i> (Blake, 1871)	Padre	
<i>Timulla leucippe</i> Mickel, 1938	Marajò	
<i>Timulla mediata mediata</i> (Fabricius, 1805)	Grenada, St. Vincent, Trinidad	
<i>Timulla mediata persa</i> Mickel, 1938	Marajò	
<i>Timulla nisa</i> Mickel, 1938	Trinidad	
<i>Timulla odice</i> Mickel, 1938	Santo Amaro	
<i>Timulla rectanguloides</i> Mickel, 1938	Grenada, Mustique, St. Vincent	E
<i>Timulla rectangula</i> (Spinola, 1841)	Cayenne, Trinidad	
<i>Timulla rufiventris</i> (Klug, 1821)	St. Vincent	
<i>Timulla rufogastra</i> (Lepeletier, 1845)	Trinidad	
<i>Timulla rufosignata</i> (Bradley, 1916)	Long Island	
<i>Timulla runata</i> Mickel, 1938	Taboga	
<i>Timulla senex</i> (Guérin-Meneville, 1844)	Cuba, Juventud	E
<i>Timulla trimaculosa</i> Mickel, 1938	Jamaica	E
<i>Timulla vagans vagans</i> (Fabricius, 1798)	Long Island	
<i>Timulla zonata</i> (Spinola, 1841)	Cayenne	
<i>Traumatomutilla americana</i> (Linnaeus, 1758)	“West Indies” (Ashmead, 1900)	
<i>Traumatomutilla incerta</i> (Spinola, 1841)	Cayenne	
<i>Traumatomutilla indica</i> (Linnaeus, 1758)	Cayenne, Marco, Trinidad	
<i>Traumatomutilla latona</i> Mickel, 1952	Trinidad	
<i>Traumatomutilla oculifera</i> (Smith, 1855)	Arapiranga, Marco	
<i>Traumatomutilla spegea</i> (Fabricius, 1804)	Cayenne, Marajó, Marco, Trinidad	
<i>Traumatomutilla vidua</i> (Klug, 1821)	Marco	
<i>Tricholabioides apicipennis</i> (Cameron, 1897)	Sri Lanka	E
<i>Trispilotilla indostana</i> (Smith, 1855)	Sri Lanka	
<i>Trogaspidia agapeta</i> (Cameron, 1902)	Borneo, Sumatra	E
<i>Trogaspidia albertisi</i> (André, 1896)	Misool, New Guinea, Roon, Salawati, Seram, Tanahbesar, Waigeo	E
<i>Trogaspidia albibrunnea</i> Chen, 1957	Taiwan	
<i>Trogaspidia alecto leucotricha</i> (Bischoff, 1920)	Zanzibar	
<i>Trogaspidia andamana</i> Hammer, 1962	South Andaman	E
<i>Trogaspidia anthylla</i> (Smith, 1860)	Ambon, Bacan, Halmahera, Seram	E
“ <i>Trogaspidia</i> ” <i>aurantissima</i> Olsoufieff, 1938	Madagascar	E
“ <i>Trogaspidia</i> ” <i>aurolimbata</i> (André, 1901)	Madagascar	E
“ <i>Trogaspidia</i> ” <i>aurovittata</i> (André 1899)	Madagascar	E
<i>Trogaspidia bakeri</i> (Mickel, 1934)	Basilan, Mindanao, Samar	E

Table 2/18. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Trogaspidia bicincta</i> (Saussure, 1867)	Sri Lanka	E
<i>Trogaspidia boniensis</i> (Mickel, 1935)	Sulawesi	E
<i>Trogaspidia bryanti</i> (Mickel, 1937)	Borneo	E
<i>Trogaspidia castellana castellana</i> (Garcia Mercet, 1903)	Luzon	E (ssp)
<i>Trogaspidia castellana islandica</i> (Mickel, 1934)	Basilan, Biliran, Mindanao, Samar	E (ssp)
<i>Trogaspidia castellana princesa</i> (Mickel, 1934)	Palawan	E (ssp)
<i>Trogaspidia castellana sandakanensis</i> (Mickel, 1935)	Borneo, Labuan	E (ssp)
<i>Trogaspidia castellana tayabasensis</i> (Mickel, 1934)	Luzon, Polillo	E (ssp)
<i>Trogaspidia castellana visayensis</i> (Mickel, 1934)	Batbatan, Negros, Panay, Sibuyan	E (ssp)
<i>Trogaspidia castellana whiteheadi</i> (Mickel, 1934)	Luzon	E (ssp)
<i>Trogaspidia catanensis</i> (Rossi, 1792)	Rava, Sicily	
<i>Trogaspidia chiaiensis</i> Tsuneki, 1993	Taiwan	E
<i>Trogaspidia cooki</i> (André, 1895)	New Guinea	
<i>Trogaspidia cressida</i> (Cameron, 1900)	Sri Lanka	E
<i>Trogaspidia cydippe</i> (Mickel, 1935)	Borneo	E
<i>Trogaspidia depressula</i> (Mickel, 1934)	Luzon	E
“ <i>Trogaspidia</i> ” <i>ditissima</i> (André, 1905)	Madagascar	E
<i>Trogaspidia doricha</i> (Smith, 1860)	Ambon, Bacan, New Guinea, Seram	E
<i>Trogaspidia eremita eremita</i> (Mickel, 1934)	Basilan, Biliran, Luzon, Mindanao, Negros, Panay, Polillo, Samar	E (ssp)
<i>Trogaspidia eremita umbra</i> (Mickel, 1934)	Luzon, Polillo	E (ssp)
<i>Trogaspidia esakii</i> Yasumatsu, 1950	Peleliu	E
<i>Trogaspidia exilis</i> (Smith, 1859)	Ambon, Kai	E
<i>Trogaspidia fervida</i> (Smith, 1860)	Sulawesi	E
<i>Trogaspidia formosana</i> (Matsumura, 1911)	Taiwan	
<i>Trogaspidia fuscipennis concava</i> (Mickel, 1933)	Taiwan	E (ssp)
<i>Trogaspidia greeni</i> Hammer, 1962	Sri Lanka	E
<i>Trogaspidia hoffmanni</i> (Mickel, 1933)	Hainan	
<i>Trogaspidia ianthea ianthea</i> (Smith, 1860)	Bacan, Halmahera, Ternate	E (ssp)
<i>Trogaspidia ianthea rubiginosa</i> (André, 1896)	Ambon, Seram	E (ssp)
<i>Trogaspidia implicata</i> (Mickel, 1935)	Sulawesi	E
“ <i>Trogaspidia</i> ” <i>incerta</i> Olsoufieff, 1938	Madagascar	E
<i>Trogaspidia indagatrix indagatrix</i> (Mickel, 1935)	Ambon	E (ssp)
<i>Trogaspidia indagatrix menadoensis</i> (Mickel, 1935)	Sulawesi	E (ssp)
<i>Trogaspidia intermedia</i> (Saussure, 1867)	Sri Lanka	
<i>Trogaspidia iphis</i> (Mickel, 1925)	Java	E
<i>Trogaspidia kauarae</i> (Cameron, 1892)	Sri Lanka	
<i>Trogaspidia kinabalensis</i> Tsuneki, 1972	Borneo	E
<i>Trogaspidia lanceolata</i> Chen, 1957	Taiwan	E

Table 2/19. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Trogaspidia lignani</i> (Mickel, 1933)	Hainan	
<i>Trogaspidia lodina</i> (Cameron, 1905)	Borneo	E
<i>Trogaspidia luzonica luzonica</i> (Radoszkowski, 1885)	Luzon	E (ssp)
<i>Trogaspidia luzonica panayensis</i> (Mickel, 1934)	Negros, Panay, Sibuyan	E (ssp)
“ <i>Trogaspidia</i> ” <i>magnifica</i> (Bischoff, 1920)	Madagascar	E
<i>Trogaspidia major</i> Nonveiller et Petersen, 1995	Inhaca	
<i>Trogaspidia manilensis</i> (Brown, 1906)	Basilan, Borneo, Luzon, Mindanao, Negros, Palawan, Panay	E
“ <i>Trogaspidia</i> ” <i>mariae bogdanovi</i> Olsoufieff, 1938	Madagascar	E
<i>Trogaspidia medon</i> (Smith, 1855)	Zanzibar	
“ <i>Trogaspidia</i> ” <i>micheli</i> Olsoufieff, 1938	Madagascar	E
<i>Trogaspidia nereis</i> (Kohl, 1882)	Java	E
<i>Trogaspidia nodoa</i> (Mickel, 1933)	Hainan	
<i>Trogaspidia oceanica oceanica</i> (André, 1896)	Baronga, Biak, Lihir, New Britain, New Guinea, New Ireland, Umboi, Yapen	
<i>Trogaspidia oceanica papuana</i> (Krombein, 1971)	Kiriwina, New Guinea, Normanby, Woodlark, Yule	E (ssp)
<i>Trogaspidia oceanica tulagiensis</i> (Mickel, 1935)	Bougainville, Buka, Choiseul, Gizo, Guadalcanal, Kolombangara, Malaita, New Georgia, Nggela, Pavuvu, Ranonga, Rendova, Santa Isabel, Savo, Tulagi, Treasury, Vella Lavella	E (ssp)
<i>Trogaspidia oceanitis</i> (Mickel, 1935)	Sulawesi, Ambon	E
<i>Trogaspidia orestes orestes</i> (Krombein, 1971)	New Guinea	E (ssp)
<i>Trogaspidia orestes trobriandensis</i> (Krombein, 1971)	Kiriwina, Normanby, Woodlark	E (ssp)
<i>Trogaspidia ovatula aurifera</i> (Mickel, 1934)	Luzon	E (ssp)
<i>Trogaspidia ovatula ovatula</i> (Mickel, 1934)	Sibuyan	E (ssp)
<i>Trogaspidia pacifica</i> Tsuneki, 1972	Taiwan	E
<i>Trogaspidia pentheus</i> (Smith, 1860)	Bacan, New Guinea	E
“ <i>Trogaspidia</i> ” <i>politana</i> (Bischoff, 1920)	Madagascar	E
<i>Trogaspidia probabilis</i> Hammer, 1962	South Andaman	E
“ <i>Trogaspidia</i> ” <i>pulcherrima</i> (André, 1905)	Madagascar	E
“ <i>Trogaspidia</i> ” <i>radachkovskii</i> Olsoufieff, 1938	Madagascar	E
<i>Trogaspidia rhea rhea</i> (Mickel, 1933)	Hainan, Taiwan	E (ssp)
“ <i>Trogaspidia</i> ” <i>sanctaemariae</i> (André, 1901)	Nosy Boraha	E
<i>Trogaspidia sansibarensis</i> Bischoff, 1920	Zanzibar	
<i>Trogaspidia sarawaka</i> (Mickel, 1935)	Borneo	E
<i>Trogaspidia saussurei</i> Lelej, 2005	Sri Lanka	E
<i>Trogaspidia scapus</i> (Mickel, 1937)	Borneo	E
“ <i>Trogaspidia</i> ” <i>seyrigiana</i> Olsoufieff, 1938	Madagascar	E
<i>Trogaspidia tethys prodiga</i> (Mickel, 1935)	Borneo	E (ssp)
<i>Trogaspidia tethys melanesia</i> (Mickel, 1935)	Ambon	E (ssp)
<i>Trogaspidia tethys tethys</i> (Mickel, 1934)	Negros, Palawan, Taiwan	E (ssp)

Table 2/20. Checklist and island distribution of the species (continued).

SPECIES	ISLANDS	
<i>Trogaspidia themis</i> (Peringuey, 1898)	Inhaca	
“ <i>Trogaspidia</i> ” <i>tricolora</i> Olsoufieff, 1938	Madagascar	E
<i>Trogaspidia tridepressa</i> Tsuneki, 1993	Luzon	E
<i>Trogaspidia vallicola</i> Tsuneki, 1993	Taiwan	E
“ <i>Trogaspidia</i> ” <i>venustulaeformis</i> (Bischoff, 1920)	Madagascar	E
<i>Trogaspidia vetustata</i> (Bingham, 1911)	Grande Comore, Inhaca	
<i>Trogaspidia villosa</i> (Fabricius, 1775)	Sri Lanka	
“ <i>Trogaspidia</i> ” <i>vitsika</i> Olsoufieff, 1938	Madagascar	E
<i>Trogaspidia yasumatsui maai</i> (Krombein, 1971)	New Hanover, New Ireland	E (ssp)
<i>Trogaspidia yasumatsui yasumatsui</i> (Krombein, 1971)	New Britain, Umboi	E (ssp)
<i>Trogaspidia yuliensis</i> Tsuneki, 1972	Taiwan	E
“ <i>Trogaspidia</i> ” <i>zanacaeformis</i> Bischoff, 1920	Madagascar	E
<i>Tropidotilla cypriadis</i> Invrea, 1940	Cyprus	
<i>Tropidotilla grisea</i> (Lepeletier, 1845)	Brač, Crete, Korčula, Sicily	
<i>Tropidotilla litoralis</i> (Petagna, 1787)	Brač, Cres, Crete, Elba, Euboea, Giglio, Kerkyra, Korčula, Kos, Lipari, Lošinj, Mljet, Mykonos, Pianosa, Rava, Rhodes, Sant’Antioco, San Pietro, Sardinia, Sicily, Šolta, Syros, Tavolara, Vulcano	
<i>Tsunekimyrmec fluctuata</i> (Smith, 1865)	Borneo, Mindanao, Negros, Samar, Tawi Tawi, Morotai	E
<i>Vanhartenidia tricolor</i> (Klug, 1829)	Djerba	
<i>Wallacidia conversa</i> (Chen, 1957)	Taiwan	
<i>Wallacidia humbertiana</i> (Saussure, 1867)	Sri Lanka	
<i>Wallacidia itambusa</i> (Cockerell, 1927)	Luzon	E
<i>Wallacidia kangeana</i> (Pagden, 1949)	Kangean, Paliat	E
<i>Wallacidia laratense</i> (Mickel, 1935)	Larat	E
<i>Wallacidia leytense</i> (Tsuneki, 1993)	Leyte	E
<i>Wallacidia melmora</i> (Cameron, 1905)	Borneo, Java, Rakata Besar, Sulawesi, Sumatra	E
<i>Wallacidia merops</i> (Smith, 1860)	Bacan, Gebe, Halmahera, Morotai, Ternate	E
<i>Wallacidia oculata</i> (Fabricius, 1804)	Dang Kho, Hainan, Phong Vong, Taiwan, Thanh Lân	
<i>Wallacidia opulenta</i> (Smith, 1855)	Sri Lanka	
<i>Wallacidia paloeana</i> (Pagden, 1949)	Sulawesi	E
<i>Wallacidia philippinense</i> (Smith, 1855)	Balabac, Borneo, Cebu, Luzon, Mindanao, Mindoro, Negros, Palawan, Panay, Polillo, Solor, Sulawesi, Ambon	E
<i>Wallacidia retinula</i> (Chen, 1957)	Taiwan	
<i>Wallacidia rosemariae</i> (O'Toole, 1975)	Flores, Lombok, Sumbawa	E
<i>Wallacidia singapora</i> (Mickel, 1935)	Singapore	
<i>Wallacidia sumbana</i> (Pagden, 1949)	Sumba	E
<i>Wallacidia timorensis</i> (O'Toole, 1975)	Timor	E
<i>Wallacidia vicina</i> (Sichel et Radoszkowski, 1870)	Ambon, New Guinea, Seram, Yule	E

Table 2/21. Checklist and island distribution of the species (continued).



SPECIES	ISLANDS	
<i>Xystromutilla cornigera</i> (Cresson, 1902)	Trinidad	
<i>Xystromutilla turrialba</i> Casal, 1969	Taboga	
<i>Yamanetilla andromeda</i> (Mickel, 1934)	Luzon, Mindanao, Negros, Samar	E
<i>Yamanetilla cassiope</i> (Smith, 1857)	Borneo	
<i>Yamanetilla nipponica</i> (Tsuneki, 1972)	Honshū, Kyūshū, Shikoku	E
<i>Yamanetilla pedaria</i> (Mickel, 1934)	Basilan, Mindanao, Palawan	
<i>Yamanetilla taiwaniana</i> (Zavattari, 1913)	Taiwan	
<i>Zavatilla gutrunae gutrunae</i> (Zavattari, 1913)	Taiwan	E (ssp)
<i>Zavatilla logei</i> (Zavattari, 1913)	Taiwan	E
<i>Zeugomutilla bainbriggei</i> (Turner, 1911)	Sri Lanka	E
<i>Zeugomutilla horni</i> (André, 1907)	Sri Lanka	E
<i>Zeugomutilla recondita</i> (Cameron, 1900)	Sri Lanka	E

Table 2/22. Checklist and island distribution of the species.

Species	Examined material
<i>Blakeius bipunctatus</i> (Latreille, 1792)	Chergui (TN), 20.IV.2005, R. Vilardo leg. (1 ex., PLC).
<i>Blakeius leopoldinus</i> (Invrea, 1955)	Salina (IT), 26.VII.2012, Fossa delle Felci, P. Lo Cascio and F. Grita leg. (3 exx., PLC).
<i>Dasylabris juxtaarenaria</i> Skorikov, 1935	Djerba (TN), Ras al-Kastil, 13.IV.2005, P. Lo Cascio leg. (2 exx., PLC).
<i>Dolichomutilla sycorax</i> (Smith, 1855)	Pemba (TZ), I.2015, F. La Piana leg. (1 ex., PLC).
<i>Mutilla diselena</i> Sichel et Radoszkowski, 1870	Pemba (TZ), I.2015, F. La Piana leg. (1 ex., PLC).
<i>Mutilla quinquemaculata</i> Cyrillus, 1787	Astypalea (GR), 25.IV.1999, P. Lo Cascio leg. (1 ex., PLC); Kassos (GR), 16-18.X.2000, P. Lo Cascio leg. (1 ex., PLC).
<i>Myrmilla caucasica</i> (Kolenati, 1846)	Nisyros (GR), 30.IV.1999, P. Lo Cascio leg. (1 ex., PLC).
<i>Myrmilla georgiae</i> Pagliano et Matteini Palmerini, 2014	Gataya el Bahria (TN), 10.IV.2015, P. Lo Cascio & P. Ponel leg. (1 ex., PLC).
<i>Myrmilla glabrata</i> (Fabricius, 1775)	Pano Koufonissi (GR), IX.1997, P. Lo Cascio leg. (1 ex., PLC).
<i>Nemka viduata viduata</i> (Pallas, 1773)	Pano Koufonissi (GR), IX.1997, P. Lo Cascio leg. (3 exx., PLC); Stromboli (IT), Rina Grande, 30.VII.2015, P. Lo Cascio leg. (3 exx., PLC).
<i>Physetopoda halensis</i> (Fabricius, 1787)	Bagaud (FR), 3.VI.2013, P. Ponel leg. (1 ex., PP).
<i>Physetopoda lampedusia</i> (Invrea, 1957)	Gremdi (TN), 27.III.2014, P. Ponel leg. (1 ex., PP).
<i>Ronisia brutia brutia</i> (Petagna, 1787)	Folegandros (GR), IX.1997, P. Lo Cascio leg. (1 ex., PLC); Panarea (IT), Punta del Corvo, 11.V.2008, P. Lo Cascio leg. (1 ex., PLC); Salina (IT), Fossa delle Felci Mount, 26.VII.2012, P. Lo Cascio and F. Grita leg. (1 ex., PLC).
<i>Ronisia brutia minoensis</i> Nonveiller, 1972	Astypalea (GR), Aghios Ioannis, 26.IV.1999, P. Lo Cascio leg. (1 ex., PLC).
<i>Sigilla dorsata</i> (Fabricius, 1798)	Embiez (FR), 22.IV.2013, P. Ponel leg. (1 ex., PP).

Table 2/22. Table 3. Unpublished records included in the checklist. The acronyms are as follows: PLC, Pietro Lo Cascio collection, Lipari (Italy); PP, Philippe Ponel collection, Marseille (France).

## FAUNAL AND BIOGEOGRAPHICAL OUTLINES

The records of Mutillidae on islands concern 774 among species and subspecies (including 8 identified at generic rank), equal to about 18% of those currently accepted as valid. Of course, this number is provisional, because many islands are still unexplored or their faunal knowledge cannot be considered as exhaustive. For instance, according to Brothers (2012) the fauna of New Caledonia includes 4 species so far described, but also a large number (probably 14 more) not yet identified; and Portuondo Ferrer & Fernández-Triana (2003) estimated the probable occurrence of 16 species on Cuba, where hitherto only 11 have been recorded. The same is also strongly suggested by the noteworthy discrepancy between the number of species known for Sicily (42) and for New Guinea (36), a tropical island thirty times larger and moreover considered one of the global biodiversity hotspots.

Despite this gap in knowledge, on the basis of the data provided in the checklist is anyhow possible to delineate an overview of the main biogeographical features of the island faunas, which are briefly discussed in the following paragraphs.

### Dispersal

As already stated in the Introduction, the main limits to the dispersal of Mutillidae on islands are related to some traits of their natural history, and primarily to the apterogyny. This would be indirectly supported by the fact that several genera whose males are also wingless, such as the Oriental Ticoplinae *Cameronilla* Lelej in Lelej & Krombein, 2001 and *Hindustanilla* Lelej in Lelej & Krombein, 2001, or the Afrotropical Sphaerophthalminae *Brachymutilla* André, 1901 and *Apteromutilla* Ashmead, 1903, are fully absent on oceanic islands. Sri Lanka is inhabited by the endemic monospecific genus *Indratilla* Lelej, 1993 as well as by some species of *Spilomutilla* Ashmead, 1903 with males apterous or having rudimentary wings (Lelej, 1993, 2005), but this island is geologically part of the Indian subcontinent and was in land connection to mainland India during the Pleistocene sea-regressions (Voris, 2000). Also, the Myrmillinae *Blakeius chiesii* (Spinola, 1839), *B. leopoldinus* Invrea, 1955 and *Myrmilla capitata* (Lucas, 1846) are found on

Mediterranean islands that generally lie near to the mainland or, such the rather isolated Sardinia and Corsica, represent fragments of continental landmass (Advokaat et al., 2014).

Except for the cases above mentioned, the females may expand the range of dispersal through the phoretic copulation, and Mutillidae have colonized remote insular groups such as Solomons (Mickel, 1935; 1937; Krombein, 1971), New Caledonia (André, 1896a; Brothers, 2012), New Zealand (Valentine & Walker, 1983), Ogasawara (Yasumatsu, 1936), Palau (Esaki, 1938), Vanuatu (Brothers, 2012) and, in the other side of the Pacific, the Galápagos (Williams, 1926). Some of them belonging to ancient continental landmasses, although characterized by long-term isolation (e.g. New Caledonia), but others have indeed volcanic origin and have never been connected to the neighboring mainland. Vanuatu, that lies 1,900 Km far from Australia, represents a remarkable case of isolation, although the sea barrier between these islands and the nearest continent is interrupted by intermediate steps (New Caledonia); is not by chance that the only species found on Espiritu Santo belongs to the genus *Ancistrotilla* Brothers, 2012, the same occurring on New Caledonia and whose distribution is also extended to Australia and New Guinea (Brothers, 2012).

Conversely, Kuhlmann (2006) has highlighted the rapid loss of Mutillidae as well as other groups of parasitic Hymenoptera eastwards of Melanesia, while Zimmermann (1942) and Williams (1947) remarked the lack of this family on large archipelagoes such as Polynesia, Hawaii, and most part of Micronesia (see also Krombein, 1949a). The same has been observed by Bequaert (1929) for the Archipelago of Bermuda (N-Atlantic), as confirmed also by more recent surveys (see Hilburn et al., 1990).

While the absence of mutillids is then rather understandable for these extremely remote islands, as well as for Bermuda, Azores and St. Helena in the Atlantic, Chagos, Seychelles and Mauritius in the Indian Ocean, it is not so easily explained for other less distant from the continental landmasses: for instance, Fernando de Noronha (370 Km), Madeira and Cape Verde (both around 600 Km) in the Atlantic, or Lord Howe (750 Km) in the Pacific. This latter, despite its very small area (<15 Km<sup>2</sup>), is inhabited by 225 species of parasitoids and



predatory wasps belonging to 31 families, many of which are brachypterous or even apterous (Jennings & Austin, 2015), but curiously not by Mutillidae, although the island could have both suitable habitats and hosts.

Is therefore to believe that isolation is not just a question of distance, but related to the nature of wind system, as observed for the Antillean butterflies by Spencer-Smith et al. (1988), or of course even stochastic.

An intriguing example for understanding time and space scales of the island colonization is given by that of the volcanic micro-archipelago of Krakatau (Indonesia) after the devastating eruption occurred in 1883. Forty years later, Dammermann (1923) recorded the occurrence of females belonging to two unidentified species (only one on Sertung, both on Rakata Besar) not found during previous surveys (see Jacobson, 1909), and once again Dammermann (1948) reported two and three unidentified species, respectively, for these islands. O'Toole (1975) remarked that at least one of them, *Wallacidia melmora* (Cameron, 1905), is able to overcome narrow sea barriers (about 50 Km) thanks to the peculiar morphology of the genitalia that ensures a prolonged female phoresy during the mating, assuming however as the colonization of new islands must necessarily occurred after the settling of its potential hosts.

Also passive dispersal (by human-mediated, accidental introductions) may play a role in the occurrence of mutillids wasps on insular environments. The Australian "*Ephutomorpha*" *bivulnerata* (André, 1901) not long ago recorded for North Island has been interpreted in this sense (Valentine & Walker, 1983). Furthermore, two females and one male of *Sphaerophthalma pennsylvanica* (Lepeletier, 1845) were recently found yet in New Zealand during the reclamation of used vehicles imported from United States (Toy, 2007); the latter record was anyway not included in the present checklist because it concerns an unnatural context. Likewise, Sugiura et al. (2013) considered *Neotrogaspidia pustulata* (Smith, 1873) an alien species in the Ogasawara Islands.

### *Species richness*

As shown in figure 1, the islands of the Indo-Malay ecoregion host the highest number of

species (356), some of which are also distributed in the neighboring regions (7 shared with Australasia, 7 with E Palearctic, and 1 with this latter and Oceania). Mutillidae are generally characterized by a greater diversity in the tropical and subtropical regions of the world (Lelej & Brothers, 2008), while in the northern areas their number strongly decrease, and this pattern seems to be confirmed also on islands when comparing Nearctic to Neotropic, or W-Palearctic to Afrotropical. It should be noted that two of the three species occurring in Great Britain have been included among the "notable" at national level due to their relative rarity (Falk, 1991). However, the noteworthy species richness of Indo-Malay may be explained also by the fact that this region includes the islands characterized by the highest number of species (Sri Lanka and Borneo, respectively with 82 and 77), as well as countries where occur a large number of islands (Indonesia and Philippines).

A highly significant correlation between island size and number of species ( $\log_{\text{species}} - \log_{\text{area}}$ :  $r = 0.569$ ,  $P = 0.0004$ ) was found for  $N = 39$  islands with a surface  $>10,000 \text{ Km}^2$  (excluding North Island, where the only occurring species has been surely introduced; Great Britain, Ireland, Vancouver and Sakhalin, whose faunal impoverishment realistically reflects a latitudinal constraint; and Marajó, that according to the literature has not been adequately investigated) (Fig. 2).

Likewise, highly significant correlations were found for Mediterranean (excluding those not adequately investigated,  $N = 47$ :  $r = 0.830$ ,  $P = 0.0001$ ) (Fig. 3), Japanese and Nansei ( $N = 21$ :  $r = 0.758$ ,  $P = 0.0001$ ) (Fig. 4), Indo-Malay (excluding Nansei,  $N = 49$ :  $r = 0.717$ ,  $P = 0.0001$ ), Australasian (excluding North Island,  $N = 54$ :  $r = 0.511$ ,  $P = 0.0002$ ; including Australia,  $N = 55$ :  $r = 0.640$ ,  $P = 0.0001$ ), Caribbean ( $N = 19$ :  $r = 0.615$ ,  $P = 0.004$ ) (Fig. 5), and Afrotropic islands ( $N = 15$ :  $r = 0.721$ ,  $P = 0.003$ ) (Fig. 6).

Highly significant linear correlations were also found between number of species and island elevation, that may give an indirect indication of the environmental heterogeneity of such territories, for Mediterranean ( $r = 0.840$ ,  $P = 0.0001$ ), Indo-Malay ( $r = 0.586$ ,  $P = 0.0001$ ), Japanese and Nansei ( $r = 0.850$ ,  $P = 0.0001$ ), Australasian ( $r = 0.614$ ,  $P = 0.0006$ ), and Caribbean (excluding Trinidad,  $N = 18$ :  $r = 0.695$ ,  $P = 0.001$ ).



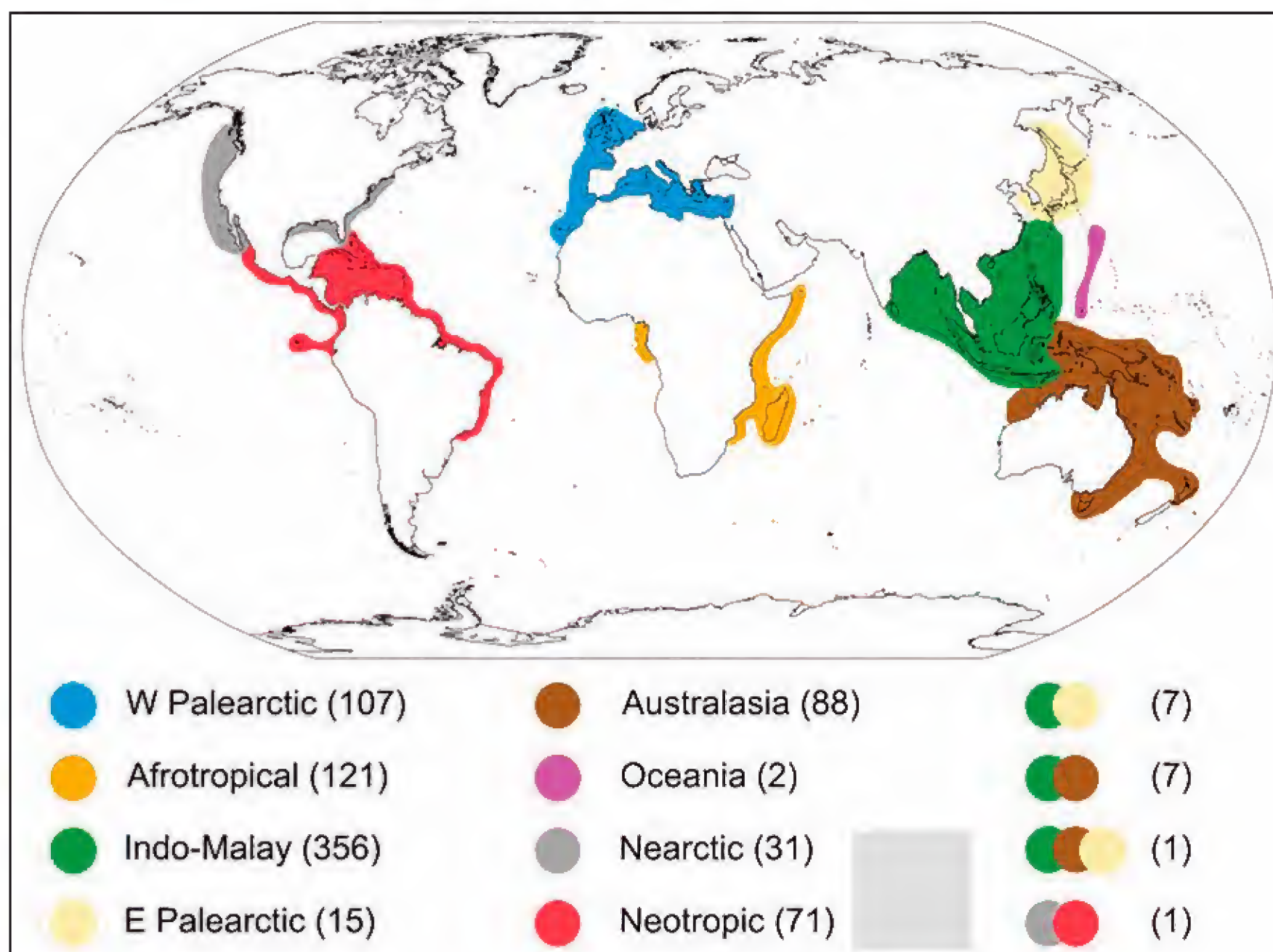


Figure 1. Number of species recorded for islands within each ecoregion. The overlapping circles and the relative number correspond to the species in common between different ecoregions.

Few islets with a surface less than 1 Km<sup>2</sup> are home to mutillids, and their localization is generally very close to the mainland: Phong Vong (< 0.5 Km<sup>2</sup>) belongs to the small coastal archipelago of Phu Quoc (southern Viet Nam); Penikese (0.3) lies in the Buzzard Bay (Massachusetts, US); Embiez (0.9) is a strongly anthropized coastal islet of southern France, while Bagaud (0.45) belongs to the Hyeres Archipelago; Lavezzu (0.7), together with the nearby Cavallo (1.2), belongs to an island group not far from the southern coast of Corsica, with which it was connected until recent times; Conigli (0.04), that can be considered the smaller example of viable surface, represents a fragment of the adjacent Lampedusa Island (Channel of Sicily, Mediterranean) and both were in connection to North Africa during the Last Glacial Maximum.

The only tiny oceanic islet inhabited by mutillids is Nishi-jima (0.49) in the Ogasawara Ar-

chipelago (Japan), but the only species found there is the same occurring on the nearby Chichi-jima.

#### *Species to genus ratio*

Species to genus ratio (S/G) has long been recognized as measure of the taxonomic disharmony of insular faunas (see Gillespie & Roderick, 2002), but in the case of Mutillidae it seems rather an indirect indicator of how the island faunas are depauperate in comparison to those of the neighboring continental areas.

Although not easily verifiable for many of the islands listed in Table 1, due to the uncertainties that still concern the status of some genera on the whole (such as *Ephutomorpha*) or their representatives in some areas (e.g. *Trogaspidia* in the Malagasy region), average S/G is clearly found to decrease on islands when comparing Japan ( $1.2 \pm 0.13$ ) and Nansei ( $1.33 \pm 0.23$ ) to China ( $3.62 \pm 0.66$ : data



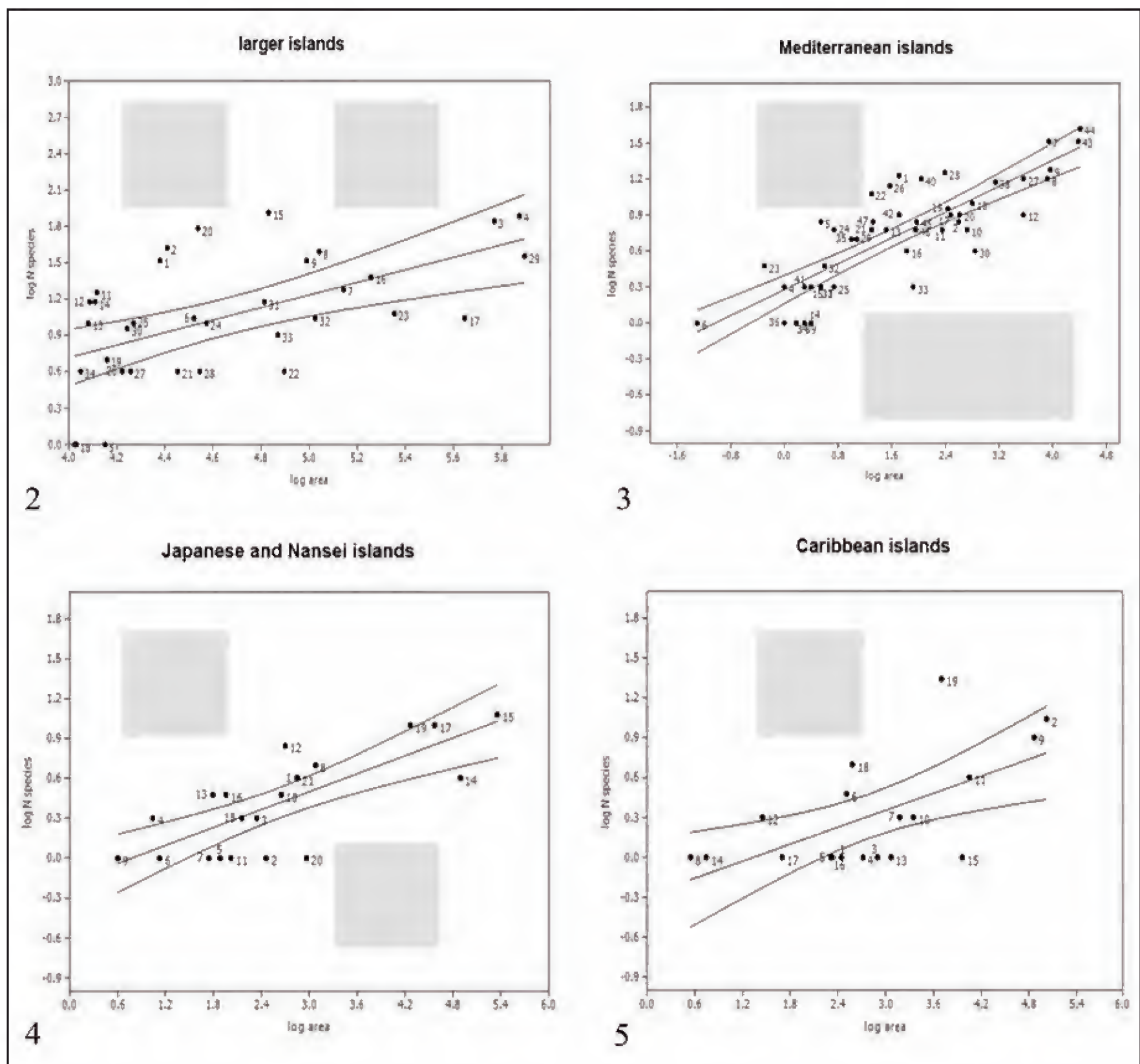


Figure 2. Species-area plot ( $\log_{\text{species}} - \log_{\text{area}}$ ) for islands  $> 10,000 \text{ Km}^2$ . Numbers are as follows: 1) Sardinia; 2) Sicily; 3) Madagascar; 4) Borneo; 5) Flores; 6) Hainan; 7) Java; 8) Luzon; 9) Mindanao; 10) Mindoro; 11) Negros; 12) Palawan; 13) Panay; 14) Samar; 15) Sri Lanka; 16) Sulawesi; 17) Sumatra; 18) Sumba; 19) Sumbawa; 20) Taiwan; 21) Timor; 22) Hokkaidō; 23) Honshū; 24) Kyūshū; 25) Shikoku; 26) Grande Terre; 27) Halmahera; 28) New Britain; 29) New Guinea; 30) Seram; 31) Tasmania; 32) Cuba; 33) Hispaniola; 34) Jamaica.

Figure 3. Species-area plot ( $\log_{\text{species}} - \log_{\text{area}}$ ) for Mediterranean islands. Numbers are as follows: 1) Asinara; 2) Brač; 3) Budelli; 4) Cavallo; 5) Comino; 6) Conigli; 7) Corsica; 8) Crete; 9) Cyprus; 10) Djerba; 11) Elba; 12) Euboea; 13) Gavdos; 14) Giannutri; 15) Gorgona; 16) Gozo; 17) Hvar; 18) Kerkira; 19) Korčula; 20) Krk; 21) La Maddalena; 22) Lampedusa; 23) Lavezzi; 24) Levanzo; 25) Linosa; 26) Lipari; 27) Mallorca; 28) Malta; 29) Marettimo; 30) Menorca; 31) Panarea; 32) Pano Koufonissi; 33) Pantelleria; 34) Piana dell'Asinara; 35) Pianosa; 36) Porquerolles; 37) Rava; 38) Rhodes; 39) San Domino; 40) Sant'Antioco; 41) Santa Maria; 42) San Pietro; 43) Sardinia; 44) Sicily; 45) Syros; 46) Vis; 47) Vulcano.

Figure 4. Species-area plot ( $\log_{\text{species}} - \log_{\text{area}}$ ) for Japanese and Nansei islands. Numbers are as follows: 1) Amami Ōshima; 2) Iriomote-jima; 3) Ishigaki-jima; 4) Iwo-jima; 5) Kakeromajima; 6) Kuchinoshima; 7) Miyakojima; 8) Okinawa-jima; 9) Takeshima; 10) Tanegashima; 11) Tokunoshima; 12) Yakushima; 13) Hachijō-jima; 14) Hokkaidō; 15) Honshū; 16) Izu Ōshima; 17) Kyūshū; 18) Okushiri; 19) Shikoku; 20) Shimoshima; 21) Tsushima.

Figure 5. Species-area plot ( $\log_{\text{species}} - \log_{\text{area}}$ ) for Caribbean islands. Numbers are as follows: 1) Antigua; 2) Cuba; 3) Dominica; 4) Eleuthera; 5) Great Exuma; 6) Grenada; 7) Guadeloupe; 8) Guana; 9) Hispaniola; 10) Juventud; 11) Jamaica; 12) Little Cayman; 13) Martinique; 14) Mustique; 15) Puerto Rico; 16) St. Croix; 17) St. John; 18) St. Vincent; 19) Trinidad.

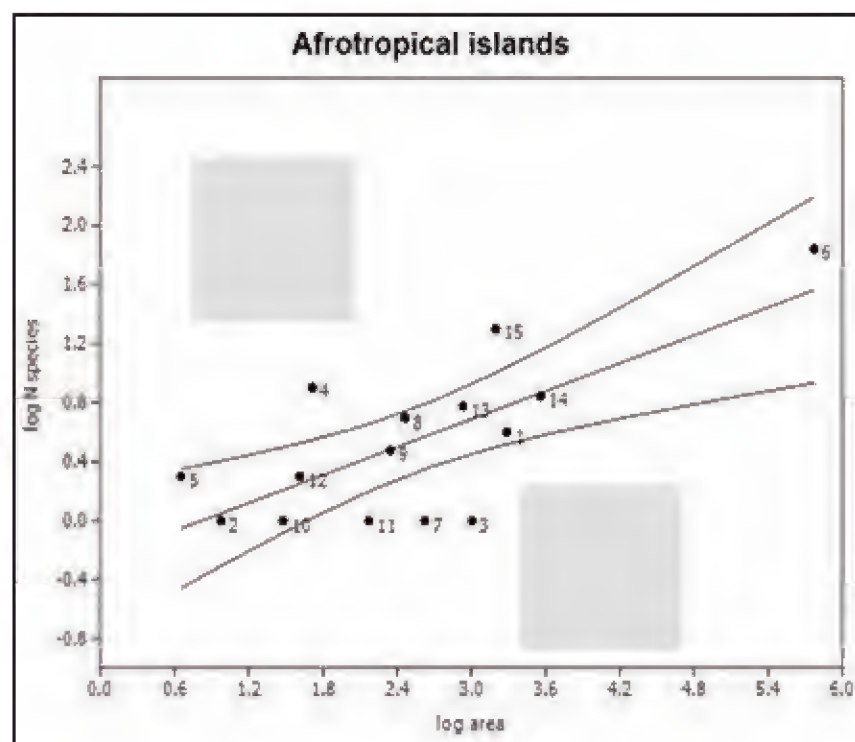


Figure 6. Species-area plot ( $\log_{\text{species}} - \log_{\text{area}}$ ) for Afrotropical islands. Numbers are as follows: 1) Bioko; 2) Fundo; 3) Grande Comore; 4) Inhaca; 5) Koyaama; 6) Madagascar; 7) Mafia; 8) Nosy Be; 9) Nosy Boraha; 10) Nosy Komba; 11) Príncipe; 12) Samha; 13) São Tomé; 14) Socotra; 15) Zanzibar.

from Lelej, 2005; Tu et al., 2014), while respect to this latter the most “continental” Taiwan has a S/G only slightly lower ( $3.16 \pm 0.75$ ); Sri Lanka ( $2.54 \pm 0.37$ ) to India ( $5.07 \pm 1.44$ : data from Lelej, 2005); Socotra ( $1.40 \pm 0.24$ ) to Yemen ( $2.05 \pm 0.33$ : data from Lelej & Harten, 2006, 2014); Sicily ( $2.33 \pm 0.59$ ) and Sardinia ( $2.00 \pm 0.55$ ) to Italy ( $2.66 \pm 0.65$ : data from Pagliano & Strumia, 2007); Crete ( $1.60 \pm 0.26$ ) and Cyprus ( $1.63 \pm 0.43$ ) to, respectively, Greece ( $2.55 \pm 0.58$ : data from Lelej et al., 2003a, 2003b; Pagliano, 2009) and Turkey ( $3.09 \pm 0.56$ : data from Yildirim & Lelej, 2012).

Furthermore, S/G for the above Mediterranean islands seems to decrease in proportion to their size with a significant difference (Kruskal-Wallis:  $H = 7.343$ ,  $P = 0.03$ ). A similar trend, albeit not statistically significant, is found both within the Greater Antilles (Cuba:  $2.75 \pm 0.85$ ; Hispaniola:  $2.00 \pm 0.70$ ; Jamaica:  $1.33 \pm 0.33$ ) and in comparison to the smaller but “continental” Trinidad ( $2.33 \pm 0.64$ ).

### Faunal affinities

Average linkage cluster analysis (UPGMA) using Jaccard’s coefficient was performed in order to evaluate the faunal similarity within four island groups.

Australasian islands (Fig. 7) constitute a clearly distinct group from Lesser Sundas and Sulawesi and are characterized by two main clusters: in the first are included Maluku and the coastal islands of western New Guinea (Biak, Misool, Roon, Salawati, Umboi, Waigeo, Yapen), while in the other are grouped New Guinea, its eastern satellites (Baronga, Daru, Kiriwina, Lihir, Normanby, Woodlark, Yule) and Bismarck Archipelago (New Britain, New Ireland, New Hanover). The greater faunistic affinity found between Papuan and Bismarck islands is due to their geographical proximity, but also to the fact that their faunas represent fractions of the high diversity of New Guinea.

Within the Sunda Islands (Fig. 8), where some islands (Sulawesi, Borneo, Java) host a large number of single-island endemics (SIEs), there is a very low degree of similarity. Borneo and Sumatra are grouped in one of the two main clusters, while the other includes Java, Lesser Sundas and, slightly separate, Sulawesi.

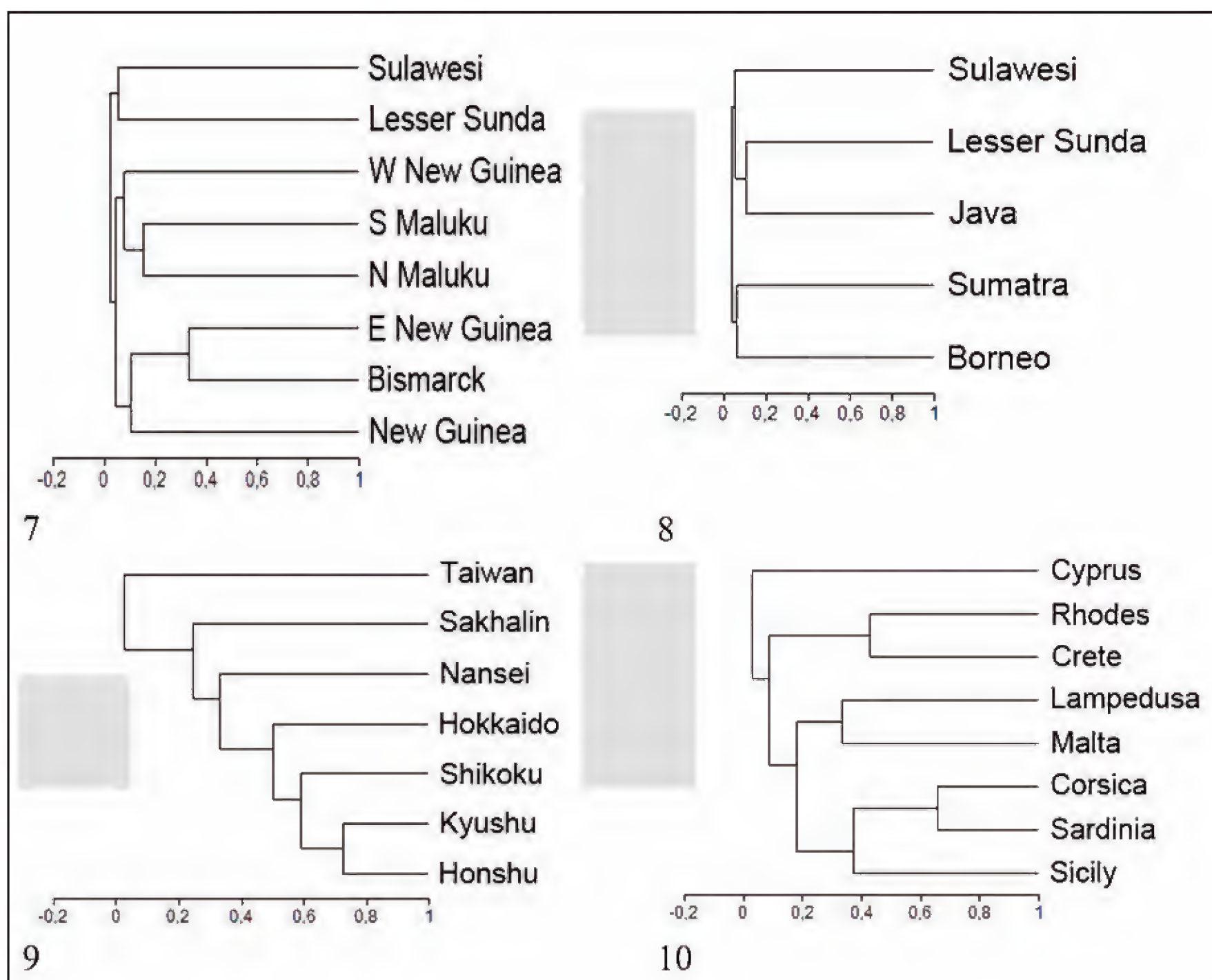
On the contrary, Japanese islands (Fig. 9) are characterized by a remarkable faunistic affinity and, secondarily, have a certain similarity with Nansei group and Sakhalin. With this latter, Japanese islands share some Palearctic elements widely distributed in the continental areas, namely *Mutilla* Mikado Cameron, 1900, *Cystomutilla teranishii* Mickel, 1935 and *Taimyrmosa mongolica* (Suárez, 1974), that conversely are lacking in the Nansei. Although Nansei belong to the Indo-Malay region, it should be noted that these islands are more closely related to Japan than to Taiwan, whose isolated cluster fits well to its noteworthy faunal distinctiveness.

Finally, the clusters of the Mediterranean area (Fig. 10) seem to reflect mainly the geographical closeness of the islands: the greater similarities were found between Corsica and Sardinia, which indeed belong to a distinct western insular group that includes also Sicily; for Malta and Lampedusa, that lie in the Channel of Sicily and relatively close to North Africa; and for Crete and Rhodes, both placed in the Aegean Sea. Probably due to its easternmost and isolated localization, Cyprus shows a very low degree of similarity with all these islands.

### Endemism

Endemism at generic rank occurs only in a restricted number of larger islands. Five distinctive





Figures 7–10. Dendrograms obtained by UPGMA clustering of some Australasian (Fig. 7), Sunda (Fig. 8), Japanese and Nansei (Fig. 9) and Mediterranean islands/island groups (Fig. 10) according to the Jaccard index similarity matrix.

genera occur both on Sri Lanka (*Bethsmymilla* Krombein et Lelej, 1999; *Indratilla* Lelej, 1993; *Kudakrumia* Krombein, 1979; *Serendibiella* Lelej, 2005; *Standfussidia* Lelej, 2005) and Madagascar (*Aureotilla* Bischoff, 1920; *Hildebrandetia* Özdikmen, 2005; *Pseudolophotilla* Nonveiller et Četković, 1995; *Seyrigilla* Krombein, 1972; *Sylvotilla* Viette, 1978), but should be noted that at least 19 Madagascan species currently ascribed to genus *Trogaspidia* Ashmead, 1899 are however belonging to other genera yet undescribed (see Brothers et al., 2011), hence the number of endemics for this island is underestimated. Endemic genera inhabit also Sulawesi (*Protrogaspidia* Lelej, 1996) and New Guinea and its adjacent islands (*Ascetotilla* Brothers, 1971) (Fig. 11), although Brothers (2012) stated that some species occurring on this latter and

assigned to *Ephutomorpha* could belong to other genera yet undescribed. Within the W Palearctic, the only insular distinctive genus is known for the Canary Archipelago (*Liomotilla* André, 1907). Finally, *Jamaitilla* Casal, 1965, described for Jamaica, has been synonymized by Quintero & Cambra (2001).

Conversely, more than half (55.8%) of the species and subspecies occurring on islands or island groups is endemic. SIEs are widely represented among specific and infraspecific taxa inhabiting large or small islands, but particularly on these latter rate of endemism may reach very high percentage values, as consequence of to their lower faunal richness. This is the case, indeed, of islands such as Fuerteventura, Príncipe, Leyte, South Andaman, Sumba, Espiritu Santo, Makira, Dominica, St. Croix, or archipelagoes such as New Caledonia and

Galápagos, for which the only/few recorded species is/are strictly endemic/s.

Figure 12 shows as the values may vary remarkably depending on the island typology. Among the larger ones, Madagascar confirms its peculiar character by hosting a wholly unique fauna, that similarly than other taxonomic groups reflects its ancient isolation (Goodman & Benstead, 2004).

High values are also found in some Greater Antilles (75% on Hispaniola, 70.8% on Cuba) and some Australasian and Indo-Malay large islands (70.8% on Sulawesi, 69.4% on New Guinea, 66.6% on Tasmania, 64.9% on Borneo).

The highly significant correlation ( $r = 0.856$ ,  $P = 0.0001$ ) found between isolation index and percentage of endemism for several islands or

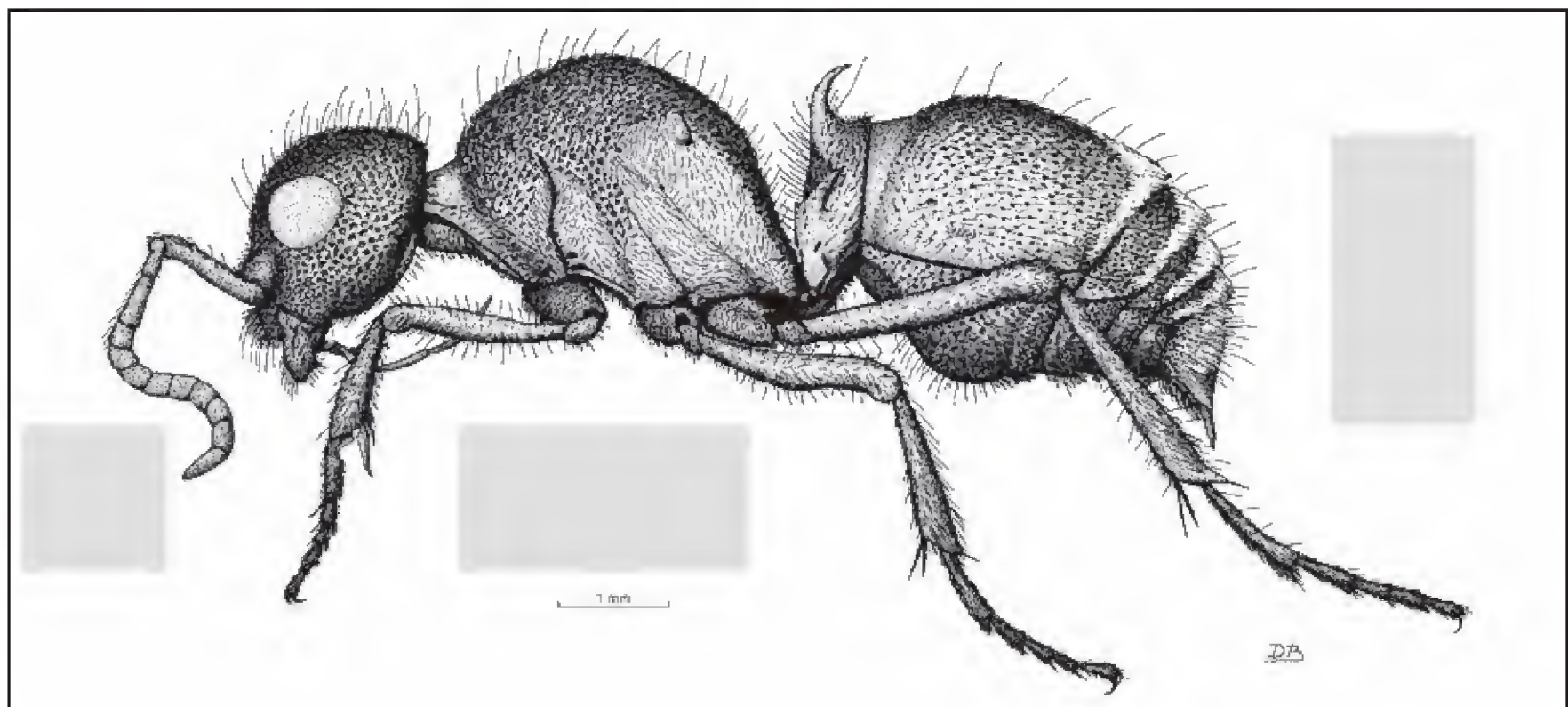


Figure 11. *Ascetotilla uncinata* Brothers, 1971, a remarkable endemic species of New Guinea (courtesy of Denis J. Brothers).

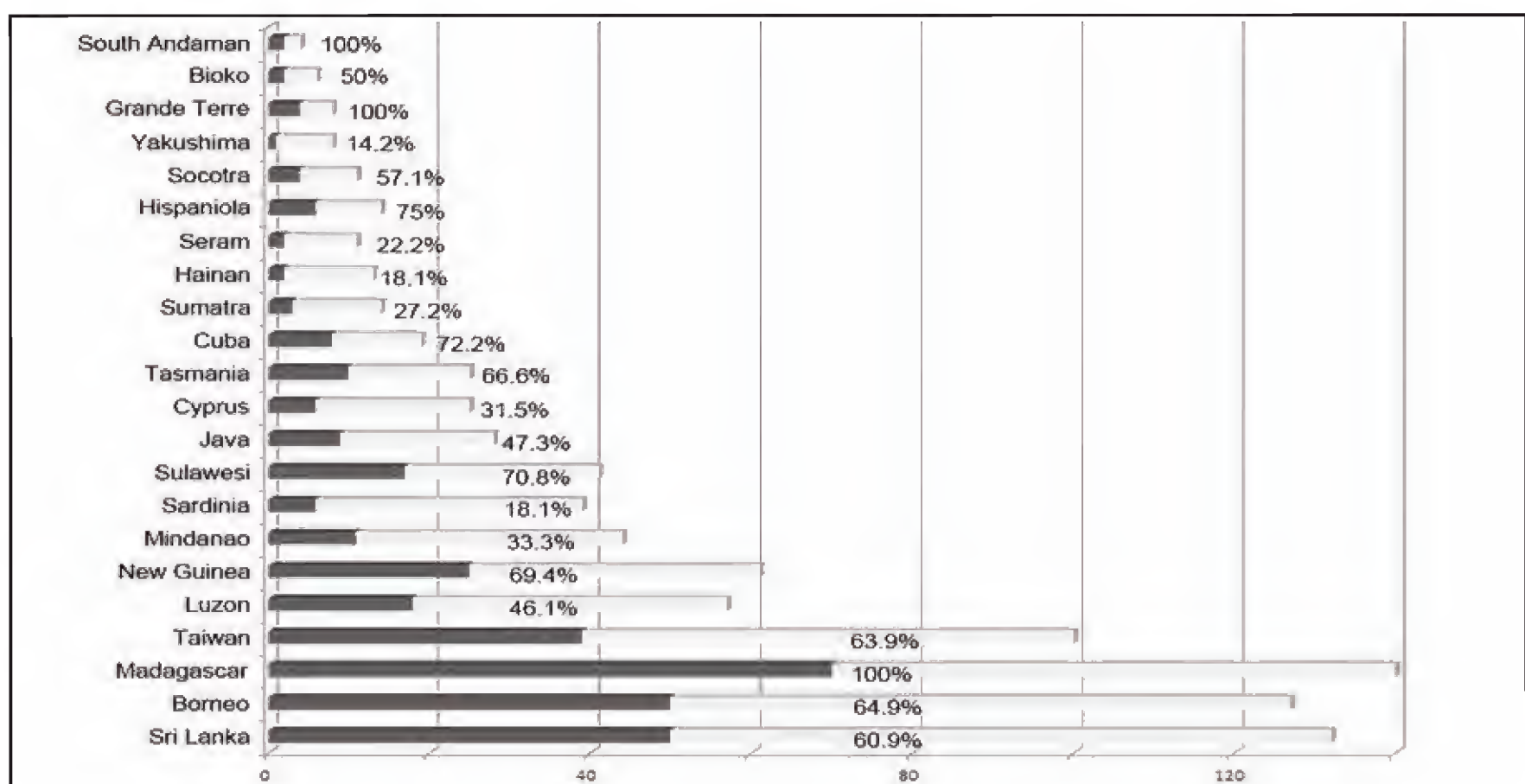


Figure 12. SIEs percentages (in dark grey) in comparison to the whole number of occurring species (in light grey) on selected islands.



archipelagoes (Fig. 13) suggests that speciation processes may be largely influenced by geographical factors, such the distance from mainland. SIEs have usually low values both in the continental islands and in those placed in closed basins (e.g. Sardinia and Cyprus in the Mediterranean). Despite the remarkable number of distinctive genera occurring on Sri Lanka, 40% of the species is indeed distributed also in the mainland. Furthermore, SIEs are absent from many Lesser Sundas (Bali, Flores, Lombok and smaller islands), in the larger Japanese islands such as Honshū, Hokkaidō and Kyūshū, in most of the W Palearctic and in all the Nearctic, which were part of continental landmasses until recent time (Last Glacial Maximum). However, considering separately each island from its insular group, not always at an oceanic origin corresponds a high level of endemism: for instance, among the Nansei only Yakushima hosts SIEs, with a value just equal to 14%.

When considering the endemics with an intra-island/archipelago distribution range, the higher percentages are found for those most isolated and inhabited by few species (e.g. Galápagos and Solomons) (Fig. 14). Fairly high percentages also occur for the islands of Gulf of Guinea, Canary and Lesser Antilles (excluding Trinidad), while both on Japanese and Nansei the endemics are <50%. Despite their geographical closeness, northern Maluku (which include Ambon, Bacan, Buru, Gebe, Halmahera, Morotai, Seram, Taliabu and Ternate) harbor a large number of species than the southern islands of the same group (Kai, Larat and Tanahbesar), but also twice of percentage of endemics (see Fig. 14). Southern Maluku derived from eastern Gondwana margin (northern Australia and southern New Guinea), while the Halmahera block (N Maluku) is thought to have originated on the Pacific plate and moved westward along the New Guinea margin to its present position (see Heads, 2013 and references therein). The different historical geography would then to account for the significant difference found in the rate of endemism for these sub-archipelagoes.

### *Niche shift*

As evidenced by Brothers (1989), records given in literature about the hosts of Mutillidae concern a very low number of species, and in general the bio-

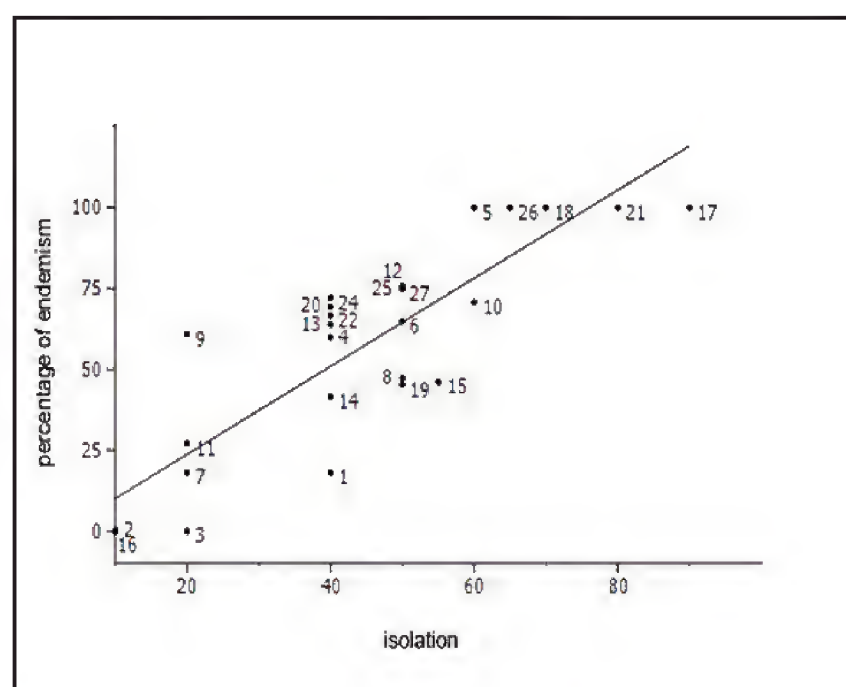


Figure 13. The relationship between isolation index (see Table 1) and percentage of endemism for some islands or archipelagoes. Numbers are as follows: 1) Sardinia; 2) Sicily; 3) Great Britain; 4) Canary; 5) Madagascar; 6) Borneo; 7) Hainan; 8) Java; 9) Sri Lanka; 10) Sulawesi; 11) Sumatra; 12) Philippines; 13) Taiwan; 14) Japanese; 15) Nansei; 16) Sakhalin; 17) Grande Terre; 18) Espiritu Santo; 19) N Maluku; 20) New Guinea; 21) Solomons; 22) Tasmania; 23) Vancouver; 24) Cuba; 25) Hispaniola; 26) Galápagos; 27) Jamaica.

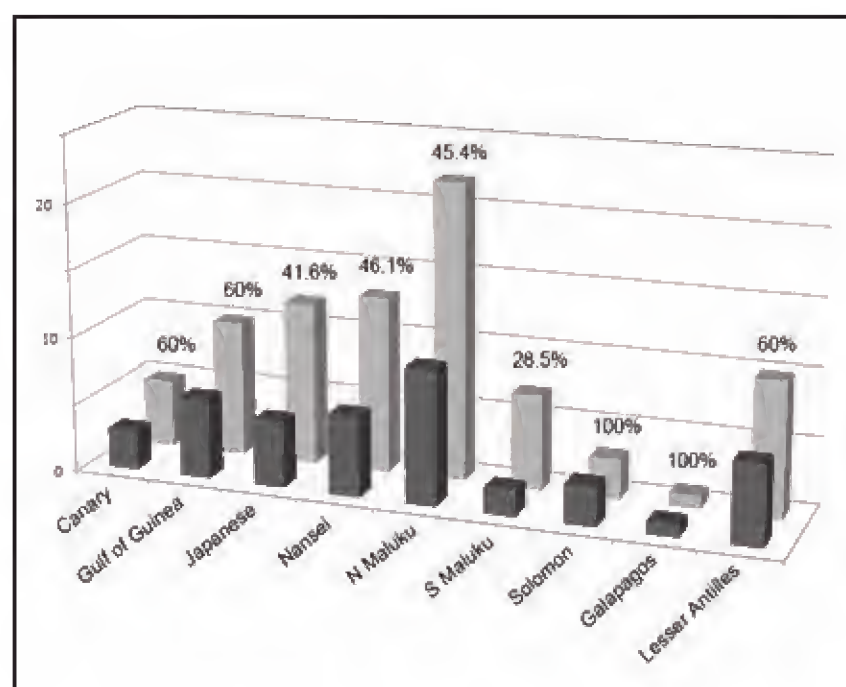


Figure 14. Intra-archipelago endemics percentages (dark grey columns) in comparison to the whole number of occurring species (light grey columns) on selected islands' groups. Lesser Antilles are here considered excluding Trinidad.

logy of these hymenopteran is little known, so eventual examples of “island rule” (sensu Gillespie & Roderick, 2002) within mutillid wasps must be viewed with caution. Nevertheless, a case of niche shift from the usual hosts (other Hymenoptera) occurring in an insular environment has been



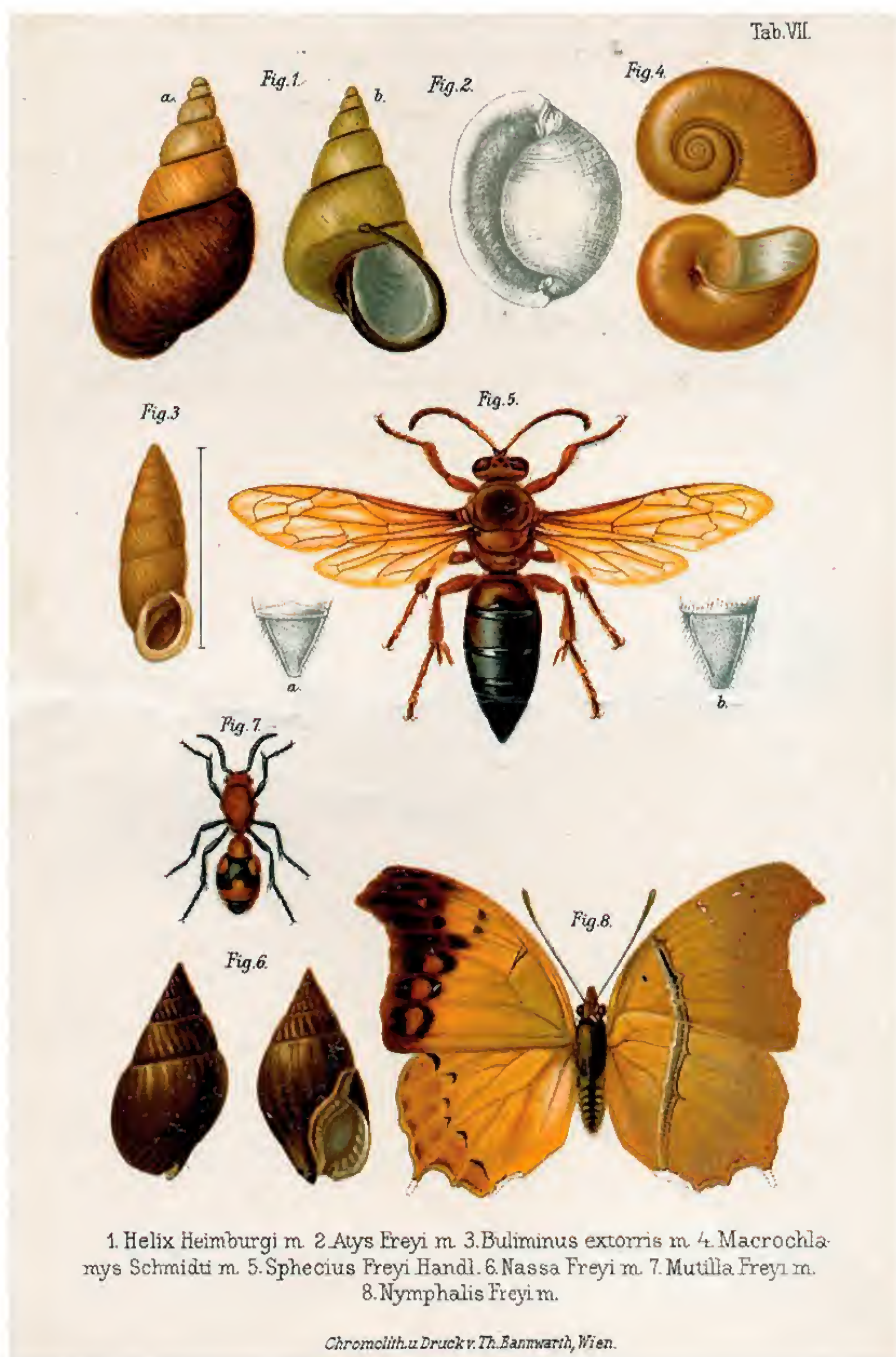


Figure 15. *Stenomutilla freyi* Branksic, 1891 from the original plate published by Branksic (1891: plate 7, fig. 7).





Figure 16. Some mutillids described from Tasmania by Westwood (1843: plate LIII), currently assigned to the genus *Ephutomorpha*.



Figure 17. Some species from Sri Lanka described and illustrated by Saussure (1867b: plate 8, figs. 1–6): *Mutilla egregia* (1) has been synonymized with *Orientilla aureorubra* (Sichel et Radoszkowski, 1870); *M. humbertiana* (2) is now placed in the genus *Wallacidia*; *M. soror* (3) and *M. bicincta* (4) are now placed in the genus *Trogaspidia*; *M. ocellata* (5) is now placed in the genus *Smicromyrme*; *M. hexaops* (6) has been synonymized with *Trogaspidia villosa* (Fabricius, 1775).



documented by Seyrig (1936) and concerns the Madagascan *Stenomutilla freyi* (Brancsik, 1891 (Fig. 15) as parasitoid of the larva of *Parasa reginula* Saalmüller, 1884 (Lepidoptera Limacodidae). Although some species have been observed to parasitize immature stages of other orders of insects, such as Diptera, Coleoptera and Blattodea (see Amini et al., 2014 and references therein), this is so far the only record of host association with a moth.

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# Three new records of freshwater fishes (Cypriniformes Cyprinidae, Atheriniformes Phallostethidae and Perciformes Osphronemidae) from Thailand

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## ABSTRACT

A priapium fish, *Neostethus lankesteri* Regan, 1916 (Atheriniformes Phallostethidae) is newly recorded from the estuary of Maeklong Basin and estuary of Chao Phraya Basin, Central Thailand; the mouthbrooder betta, *Betta prima* Kottelat, 1994 (Perciformes Osphronemidae) is newly recorded from the small stream in Chonburi Province, East Thailand, and *Rasbora daniconius* (Hamilton, 1822) is a new record for Tenasserim Basin, west Thailand. Description and distribution data of the three freshwater fish are provided here.

## KEY WORDS

*Neostethus lankesteri*; *Betta prima*; *Rasbora daniconius*; Phallostethidae; Osphronemidae.

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## INTRODUCTION

The mouthbrooder betta, *Betta prima* Kottelat, 1994 is distributed in Southeast Basin, Thailand and some areas of Mekong basin in Thailand, Cambodia and Laos. First record of *B. prima* in Thailand was reported by Kottelat (1994) in Creek on the road to Nam Tok Phliu, after leaving Chantaburi-Trat highway in Chantaburi Province. Currently, in Thailand, *B. prima* was reported in Southeast Basin (Rayong Province; Chantaburi Province; Trat Province) (Sontirat et al., 2006).

The priapium fish genus *Neostethus* Regan, 1916 is distributed in Southeast Asia only (Myers, 1928; Parenti, 1984). First record of *Neostethus* in

Thailand was reported by Myers (1937: sub *N. siamensis*), where Siam refers to the old name of Thailand, from the estuary of Chantaburi River, Southeast Basin, Thailand, this species was considered a junior synonym of *N. lankesteri* Regan, 1916 (Parenti, 1989). Currently, in Thailand, *N. lankesteri* Regan, 1916 is known only from estuary of Chantaburi River, Southeast Basin and estuary of Petburi Basin, Thailand (Kunlapapuk et al., 2012).

The cyprinid fish, *Rasbora daniconius* (Hamilton, 1822) is distributed from India to Indochina. In Thailand, *R. daniconius* is known only from Chaophaya Basin, Mekong Basin, Salween Basin and Suratthani Province, South Thailand.

In a survey project involving second author (K.S.) in Maeklong and Chao Phraya Basin, Central

Thailand during February–August 2013, the author found several specimens of *N. lankesteri* in the estuary of Maeklong Basin, Meuang District, Samut Songkhram Province and estuary of Chao Phraya Basin, Meuang District, Samut Prakan Province, Central Thailand, which is a new record of *N. lankesteri* in this region.

Moreover, during a survey project, carried out from October 2013 on Chon Buri Province, East Thailand, involving the second author (K.S.), it was found two specimens of *B. prima* in a small hill stream of Khao Krew mountain, Srisacha District, Chon Buri Province. These specimens are new record of *B. prima* in Chon Buri Province. Currently, the specimens of *N. lankesteri* and *B. prima* are deposited into the reference collection room, Inland Fisheries Resources Research and Development Institute, Department of Fisheries, Thailand (NIFI), and the authors re-examined all specimens of the cyprinid fishes *R. daniconius* stored in NIFI. The authors found that the specimens of *R. daniconius* from Tenasserim Basin, west Thailand is a new record for the region.

ACRONYMS AND ABBREVIATIONS. Standard length: SL; head length: HL; Inland Fisheries Resources Research and Development Institute, Department of Fisheries, Thailand: NIFI.

## RESULTS

### SYSTEMATICS

Order ATHERINIFORMES Rosen, 1966  
Family PHALLOSTETHIDAE Regan, 1913

*Neostethus lankesteri* Regan, 1916

EXAMINED MATERIAL. NIFI 04975, 25 specimens, estuary of Maeklong Basin, Meuang District, Samut Songkhram Province, Central Thailand, II–IX.2013, legit Sitthi Kulabtong (Fig. 1); NIFI 04976, 7 specimens, estuary of Chao Phraya Basin, Meuang District, Samut Prakan Province, Central Thailand, II–X.2013, legit Sitthi Kulabtong.

DESCRIPTION. *Neostethus lankesteri* is compress, body depth is 26.6–29.3 %SL. Body width is 8.6–11.2 %SL. Scales in lateral series are medium to large, lateral series scales include 24–27 scales, predorsal scales are 10–12. Head length is 26.8–31.1

%SL. The eyes is large, eye diameter is 35.7–37.9 %HL (8.6–11.1 %SL). Post orbital length is 43.8–46.4 %HL (10.1–14.6 %SL), snout length is short, with 17.9–20.1 %HL (5.0–7.1 %SL) and interorbital width is 46.9–50.4 %HL (10.9–11.8 %SL). Dorsal fin origin is anterior anal fin origin, predorsal fin length is 57.7–62.8 %SL, prepectoral fin length is 30.6–32.2 %SL, prepelvic fin length is 46.5–51.1 %SL and preanal fin length is 64.1–66.9 %SL. Caudal peduncle depth is 10.0–10.9 %SL. Pectoral fin is short not reaching beyond anus, the pectoral fin length is 14.3–16.2 %SL and 8–9 branched fin rays. Pelvic fin is short not reaching beyond anus, the pelvic fin length is 8.0–9.2 %SL with 7 branched rays. Anal fin base is longer than dorsal fin base, the anal fin base length is 10.6–13.4 %SL, dorsal fin with 2 unbranched rays and 7 branched rays and anal fin with 3 unbranched rays and 5 branched rays. The dorsal fin base length is 8.3–9.5 %SL.

BIOLOGY AND DISTRIBUTION. In this study all specimens of *N. lankesteri* were found in mangrove and estuary (salinity more than 20 ppt; depth about 1 m or more, mud on the bottom). In Thailand, this species is known only from estuary of Chantaburi River, Southeast Basin and estuary of Petburi Basin, Thailand. It is a new record for estuary of Maeklong and Chao Phraya Basin, Central Thailand.

Order PERCIFORMES Bleeker, 1859  
Family OSPHRONEMIDAE Bleeker, 1859

*Betta prima* Kottelat, 1994

EXAMINED MATERIAL. NIFI 04977, 2 specimens, small hill stream of Khao Krew mountain, Srisacha District, Chon Buri Province, East Thailand, X. 2013, legit Sitthi Kulabtong (Fig. 2).

DESCRIPTION. *Betta prima* is compress, body depth is 35.6–36.3 %SL. Body width is 8.7–12.1 %SL. Scales in lateral series are medium to large, lateral series scales are 26–28, predorsal scales are 21–22. Head length is 31.8–32.1 %SL. The eyes are large, eye diameter is 30.7–31.9 %HL (9.5–10.3 %SL). Post orbital length is 50.1–52.4 %HL (16.2–16.6 %SL), snout length is short, with 19.2–19.4 %HL (6.2–7.1 %SL). Dorsal fin origin is anterior anal fin origin, predorsal fin length is 67.5–67.8





Figures 1. *Neostethus lankesteri*, 22 mm SL (male) from MaeKlong Basin, Central Thailand. Figures 2. *Betta prima*, 32 mm SL from Khao Krew mountain, Chon Buri Province, East Thailand. Figures 3. *Rasbora daniconius*, 52 mm SL from Tenasserim Basin, West Thailand.

%SL, prepectoral fin length is 32.6–33.7 %SL, pre-pelvic fin length is 40.5–42.4 %SL and preanal fin length is 53.7–54.6 %SL. Caudal peduncle depth is 18.0 – 19.1 %SL. Pectoral fin is long reaching beyond anus, the pectoral fin length is 23.3–24.7 %SL. Pelvic fin is long reaching beyond anus, the pelvic fin length is 35.2–35.7 %SL. Anal fin base is longer than dorsal fin base, the anal fin base length is 44.7–45.6 %SL and dorsal fin base length is 12.3–12.5 %SL.

**BIOLOGY AND DISTRIBUTION.** *Betta prima* were found at a small hill stream in the Khao Krew mountain. The stream is transparent, running slowly, average depth about less than 50 cm, stream ground is made of rough sand. In Thailand, this species is known from Southeast Basin in Rayong Province, Chantaburi Province and Trat Province. It is a new record for Khao Krew mountain, Chon Buri Province, East Thailand.

Order CYPRINIFORMES Bleeker, 1859  
Family CYPRINIDAE Cuvier, 1817

***Rasbora daniconius*** (Hamilton, 1822)

**EXAMINED MATERIAL.** NIFI 03044, 2 specimens, Tenasserim Basin, Thailand, no collecting date, legit Dr. Chavalit Vidthayanon (Fig. 3).

**DESCRIPTION.** *Rasbora daniconius* is compress, body depth is 24.6–29.1 %SL. Body width is 7.6–10.4 %SL. Scales in lateral series are medium to large, lateral series scales are 24–27, predorsal scales are 28–33. Head length is 25.4 – 29.3 %SL. Snout length is 28.4–32.1 %HL and interorbital width is 45.7–51.1 % HL. Dorsal fin origin is posterior anal fin origin, predorsal fin length is 56.7–58.2 %SL, prepectoral fin length is 26.5–26.8 %SL, prepelvic fin length is 52.5–52.7 %SL and preanal fin length is 77.3–78.9 %SL. Caudal peduncle depth is 10.2–13.3 %SL. Pectoral fin is short not reaching beyond anus, the pectoral fin length is 14.2–16.5 %SL. Pelvic fin is short not reaching beyond anus, the pelvic fin length is 16.1–16.4 %SL. Anal fin base is shorter than dorsal fin base,

the anal fin base length is 9.5–10.1 %SL and dorsal fin base length is 16.3–17.1 %SL.

**BIOLOGY AND DISTRIBUTION.** In Thailand, this species is known only from Mekong Basin, Chao Phraya Basin, Salween Basin and Peninsular Thailand. It is a new record for Tenasserim Basin, west Thailand.

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# Diversity and distribution of bats (Mammalia Chiroptera) in Burkina Faso

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## ABSTRACT

Herein we review available information on the bat fauna of Burkina Faso, synthesizing data on a considerable number of museum specimens collected in the country between 1964 and 2010. We aim to give an exhaustive review of the locally occurring taxa and their distribution overlaid on different phytogeographic areas. To achieve this objectives, available information about bats in Burkina Faso were gathered to a database from scientific publications and museums from 1964 to 1993. This database was complemented by new field collections from 2002 to 2009. In total, 3,480 bat specimens, collected over a period of 46 years from 164 localities and belonging to 51 species, were examined. The different taxa are distributed into 24 genera and nine families. The fauna includes the following families: Pteropodidae (seven species), Hipposideridae (seven species), Emballonuridae (three species), Nycteridae (five species) and Molossidae (six species) and occur in all phytogeographical zones in Burkina Faso. However, Rhinolophidae (three species) were absent in the North-Sahelian zone but occur in the other parts of the country. Similarly, Vespertilionidae (17 species) were absent in the South-Sahelian. Rhinopomatidae (two species) were only present in the extreme north and the extreme south of the country, while the Megadermatidae (one species) were present only in the Sudanian zone.

## KEY WORDS

Bat; Burkina Faso; distribution; species richness; West Africa.

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## INTRODUCTION

Significant collections of bats from Burkina Faso are preserved in several museums. The most important one is found in the National Museum of Natural History at Washington D.C. (USNM) and comprises more than 1,100 specimens. They come from a project on mammal collection, the Smithsonian Institution African Mammal Project conducted between 1961 and 1972 in 20 countries of North, West and South Africa (Schmidt et al., 2008).

The first publication referring to bats from Burkina Faso was made by Kock (1969), who mentioned three species from Nouna. The second one was produced by Poché (1975) who mentioned six species, including five new ones for Burkina Faso, among USNM specimens collected by the Smithsonian Institution African Mammal Project. A year later, another species from Bobo-Dioulasso was quoted by Adam & Hubert (1976). The first study which dealt specifically with bats of Burkina Faso was conducted by Koopman et al. (1978). They

listed a total of 27 species including 18 new ones for the country. Then, Green (1983) collected nine species in Burkina Faso including one new for the country. Between 1980 and 1981, another major study of bats from Burkina Faso was conducted by Koch-Weser (1984). She published 24 species including six first records for Burkina Faso. Two species deposited at USNM in 1965 and 1968 were published in 2006 by African Chiroptera Project (2006). By 1984, 36 species of bats had already been identified in Burkina Faso. Since the late 1980s, no first record has been reported from Burkina Faso. Meanwhile, many other species have been reported in neighboring countries (Kock et al., 2002; Djossa, 2007; Weber & Fahr, 2007; Fahr, 2008). Also, the principal study for West African bats species made by Rosevear (1965) mentioned a lot a species present in West Africa and not yet encountered in Burkina Faso. In addition, it is now well established that only intense and long term sampling can lead to accurate estimations of species richness and abundance (Kalko et al., 1996; Simmons & Voss, 1998; Bergallo et al., 2003; Sampaio et al., 2003), which in turn represent important indices in biodiversity conservation planning (Lim & Engstrom, 2001; Andelman & Willig, 2002).

Therefore, our study will be based on this work and will consist initially in gathering all existing information on bats of Burkina Faso, conducting field trips for capturing and identifying the various species, multiplying opportunities of capturing new species for the country and particularly, in establishing the geographical coordinates of areas in which species are captured or observed. It will thus increase for sure the number of species of bats present in Burkina Faso and especially a significant increase of geographical coordinates of species because the results achieved will be used later for modeling the distribution of bats in the country. This modeling will help to have an idea of the variation in the richness of species across the entire national territory and therefore, to identify areas with high potential, that is to say, areas that contain a great variety of bats. Since it is from the modeling results that measures will be taken for the conservation of bats in Burkina Faso, it was necessary to identify the various areas to prospect for a wide coverage, to put a particular emphasis on areas that can potentially contain a large number of species and manage to identify different sites in these areas

where sampling will be made. And for that, we formulated the following assumptions.

Weather determines the richness of species (Hawkins et al., 2003). Indeed, according to Tews et al. (2004), the majority of studies shows that there is a positive correlation between habitat heterogeneity and diversity of species (August, 1983). From the North to South of Burkina Faso, there is an increase in rainfall and hence an improvement of vegetation with the savanna which gets gradually grassy and shrubby, tending towards a woodland in the far Southwest. The North of the country which is less watered and thus covered by sparse vegetation will be therefore less rich in species than the south which is well watered and with more developed vegetation. Climate is not the only factor influencing species richness and may not explain the diversity pattern for all taxonomic groups (Hawkins et al., 2003). Indeed, availability, abundance and distribution of food resources are also significant factors that affect the organization and dynamism of bats (Kalko et al., 1996; Kalko, 1997, 1998). Since there is an increase in biomass in Burkina Faso from north to south, we can conclude that diversity is higher in the South thanks to the increase of this biomass that will allow each species to find the resources needed for their food.

As observed by some authors (Bernard, 2001; Lim & Engstrom, 2001; Kalko & Handley, 2001; Sampaio et al., 2003), there is a positive correlation between complexity of habitat and diversity of bats, complexity of habitat being the vertical development of vegetation (August, 1983). In addition, complex habitats can provide more nests and allow the exploitation of environmental resources in various ways and thus increase species diversity (Bazzaz, 1975). And as the South of the country has a set of specific habitats such as the various protected forests, gallery forests and the numerous rock formations such as the cliffs of Banfora, peaks of Sindou and the range of Gobnangou that increase the complexity of the environment, we believe that this area can contain bats in abundance. Indeed, these rock formations provide additional shelters to bats through the various cracks and caves they have.

As already shown by Fahr & Kalko (2010), the diversity of bats increases with environmental heterogeneity and habitat complexity. Added to availability of food resources, the South may potentially contain a great diversity of bats. In addition,



all existing information on bats in Burkina Faso from publications and museums indicate that many areas had not yet been visited or had been poorly studied especially in the Southwest. That's why we naturally put a particular focus on this part of the country to fill the sampling gaps. For this, the latest publication referring to bats from Burkina Faso was made by Kangoyé et al. (2012). She captured 45 species among which 15 species including 2 frugivorous and 13 insectivorous were recorded for the first time in Burkina Faso. These new species recorded increased the bats diversity of Burkina Faso from 36 to 51.

## MATERIAL AND METHODS

### Study area

Burkina Faso is a Sahelian country with a total area of 274,200 km<sup>2</sup> and landlocked in the heart of West Africa. It occurs between 9°20'–15°3' N and,

2°20'E–5°3' W. It is bounded by Niger, Mali, Ghana, Ivory Coast, Benin and Togo. The majority (about 75%) of the country occurs on crystalline Precambrian basement rock, which gives a generally flat terrain (Ministère de l'Environnement et de l'Eau, 1999). The hydrographic network is relatively dense despite the precarious weather conditions (Dipama, 2010). Burkina Faso is characterized by a tropical climate, precisely a Sudano-Sahelian one, generally alternating two seasons: a long dry season from October to April and a short rainy season from May to September. The larger portion of the country lies in the Sudanian climatic zone, including central and southern parts. The northern area is under the influence of Sahelian climate (Ministère de l'Environnement et de l'Eau, 1999).

According to Guinko (1984) and Fontès & Guinko (1995), we distinguish two major phytogeographic areas on the basis of climate, vegetation and fauna: the Sahelian and the Sudanian areas, each divided into two sectors (north and south) (Fig. 1).

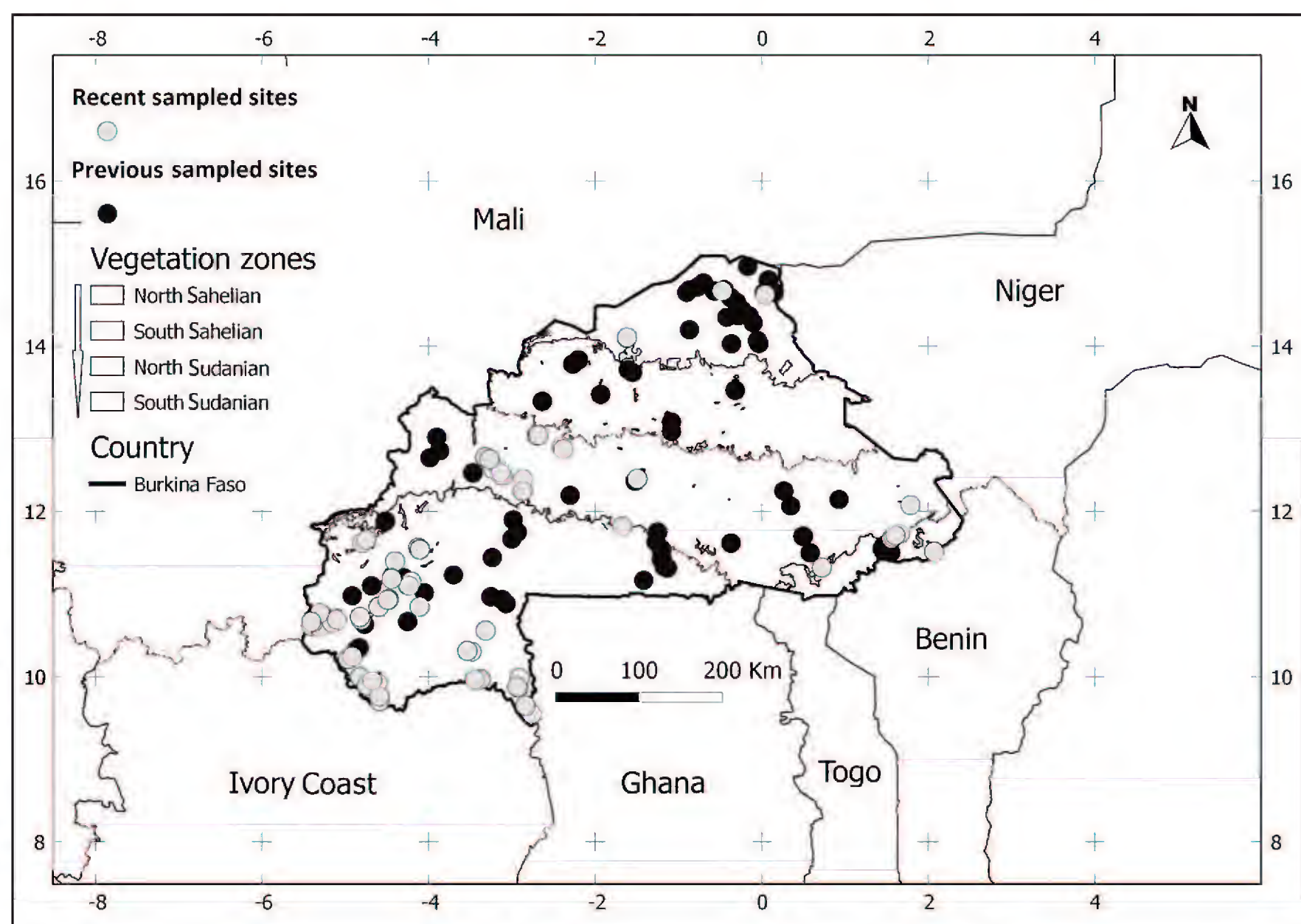


Figure 1. Previous and recent sampling sites of bats in Burkina Faso in relation to vegetation zones.



Sahelian phytogeographical vegetation area includes tree and shrub steppes, grassy steppes, tiger bush and riparian formations (Ganaba, 2008). North-Sahelian area lies north of the fourteenth parallel and is characterized by a set of species typical of the Sahara and Sahel that rarely occur further to the south in the country. South-Sahelian zone extends between the thirteenth and fourteenth parallel. This is the area where interfere many Sudanian ubiquitous species, but the general appearance of vegetation, low enough, is dominated by the Sahelian and Saharan elements. The Sudanian phytogeographic area is located south of the thirteenth parallel.

The vegetation is characterized by a set of savannas (from woodland to grassland). North-Sudanian area is located between the thirteenth and twelfth parallel (13° and 11° 30'). Savannas have the look of rustic landscapes. South-Sudanian sector is the area below the parallel 11° 30'. The vegetation is dense. Savannah is generally higher and better covering.

### **Data collection**

The first phase of this work consisted in gathering all publications made on the bats of Burkina Faso. At this level, information about all species as well as areas where the species were found, especially geographic coordinates have been collected and integrated to a data base. Secondly, data from museums hold specimens from Burkina Faso were used to complete our data base. Specimens from Burkina Faso are conserved in museums including: American Museum of Natural History, New York (AMNH); Natural History Museum, London (BMNH); Muséum d'Histoire naturelle Genève (MHNG); Muséum national d'Histoire naturelle, Paris (MNHN); Musée Royal de l'Afrique Centrale, Tervuren (MRAC); Royal Ontario Museum, Toronto (ROM), Senckenberg Museum, Frankfurt/M. (SMF), and National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). Most collections have been personally reviewed by Dr. Jakob Fahr (BMNH, MHNG, MNHN, and USNM). Sampling sites and coordinates are presented in Table 1.

Recently, new data were collected by Laurent Granjon and his colleagues either during field trips mainly devoted to rodent sampling (from 2002 to 2005), or within the framework of the FSP (Fonds

de Solidarité Prioritaire) project N° 2002-87 "Gestion durable des ressources sylvo-pastorales et production fourragère dans l'Ouest du Burkina-Faso" (from 2006 to 2008). These specimens are housed at the University of Braunschweig in Germany and IRD Bamako. Sampling sites, coordinates, dates of capture, number of nets used and capture effort made are presented in Table 2. Finally, the most recent data were collected by the BIOTA project (Biodiversity Monitoring Transect Analysis in Africa) from 2008 to 2009. This last data, that represents the main contribution to this paper, permitted to fill sampling gaps and led to the description of some species new for Burkina Faso (Kangoyé et al., 2012). The corresponding specimens are housed in the University of Ouagadougou, Burkina Faso. Sampling sites, coordinates, dates of capture, number of nets used and capture effort made are presented in Table 3. All collection localities are mapped in figure 1.

During BIOTA collect, we captured bats with Japanese nylon or polyester nets of Vohwinkel mark (length: 6 m or 12 m, height: 2.80 m, 5 floors, mesh: 16 mm, denier 70/2) black. A Garmin GPS 12 was used to take the coordinates of the sites visited. The nets have been installed and open, either all night from 6 pm to 6 am, 6 pm to 12 pm and from 4 am to 6 am, or part of the night from 6 pm to 12 pm depending on the movement of bats. The nets were visited regularly to remove the bats captured according to the intensity of capture. Each captured bat was placed individually in a capture cotton bag. Each bat was then weighed with a Pesola weighing machine with an accuracy of 0.25 g, 1g or 2 g depending on the size of the specimen. The forearm of the bat was measured with a Mahr caliper 16U with an accuracy of 0.1 mm.

The following parameters were recorded: sex, age (juvenile, sub-adult, young-adult or adult) according to Antony (1988), the reproductive status (testicles in the abdomen or testicles in the scrotum for males; nulliparous, pregnant, lactating or post-lactating for females) according to Racey (1988). Bats were therefore identified using the keys of Rosevear (1965), Hayman & Hill (1971) and the compilation of Bergmans (2002). Once identified, bats were released on site.

Species which were difficult to identify and other specimens were conserved in alcohol 70% to verify identification, to confirm their presence in



Locality	Latitude	Longitude	Publications
Aribinda	14.200	-0.867	Koch-Weser, 1984
Arli River	11.517	1.467	Green, 1983
Arli-NP	11.550	1.450	Koopman et al., 1978; Green, 1983
Arly	11.583	1.467	Poché, 1975; Green, 1983; Bergmans, 1988; Van Cakenberghe & De Vree, 1993
Bal-y-ata	14.283	-0.100	Koch-Weser, 1984
Banfora	10.633	-4.767	Bergmans, 1988
Barga	13.783	-2.267	Poché, 1975; Koopman et al., 1978
Barga (9 km NE)	13.833	-2.200	Koopman et al., 1978; Van Cakenberghe & De Vree, 1998
Bigou River	11.500	0.583	BMNH
Bobo Dioulasso	11.200	-4.300	Koch-Weser, 1984; Bergmans, 1988
Bokouongou River	11.500	1.550	Green, 1983
Bontiolé (Bougouriba River)	10.883	-3.067	Hill & Harrison, 1987
Boromo	11.750	-2.933	Koopman et al., 1978; Koch-Weser, 1984
Bossey-Dogabe	14.533	-0.300	Koch-Weser, 1984
Bourzanga	13.683	-1.550	Koch-Weser, 1984; Kock et al., 2001
Boussouma (5 km N)	12.967	-1.083	Koopman et al., 1978; Bergmans, 1988
Cella (1 km N)	11.617	-0.367	Koopman et al., 1978; Bergmans, 1989
Comoé River	9.950	-4.633	Hill & Harrison, 1987
Dedougou	12.467	-3.467	Koch-Weser, 1984
Deux Bales (Black Volta River)	11.667	-3.000	BMNH
Diebougou	10.967	-3.250	Koch-Weser, 1984; Kock et al., 2001
Dindéresso	11.217	-4.433	Hervy & Legros, 1981c
Dio	13.333	-2.633	Koopman et al., 1978; Sakamoto et al., 1979; Van Cakenberghe & De Vree, 1998
Diomga	14.067	-0.050	Koch-Weser, 1984; Kock et al., 2001
Djibo	14.100	-1.617	Koch-Weser, 1984; Aulagnier et al., 1987
Djipologo	10.933	-3.117	Koopman et al., 1978; Robbins et al., 1985; Bergmans, 1988; Van Cakenberghe & De Vree, 1993; Van Cakenberghe & De Vree, 1998
Dori	14.033	-0.033	Koch-Weser, 1984; Aulagnier et al., 1987
Fada N'Gourma	12.067	0.350	Robbins et al., 1985
Fo	11.883	-4.517	Poché, 1975; Koopman et al., 1978; Bergmans, 1988; Bergmans, 1989; Bergmans, 1991; Koch-Weser, 1984
Forêt de Lera	10.600	-5.317	Hervy & Legros, 1981c
Founzan	11.450	-3.233	Koopman et al., 1978; Van Cakenberghe & De Vree, 1985; Bergmans, 1988; Van Cakenberghe & De Vree, 1993; Van Cakenberghe & De Vree, 1998
Gandéfabou	14.767	-0.700	Koch-Weser, 1984
Goden	12.200	-2.300	Poché, 1975; Koopman et al., 1978; Robbins et al., 1985; Van Cakenberghe & De Vree, 1993
Gorgadji (17 km E)	14.033	-0.367	Koopman et al., 1978
Gorom-Gorom	14.433	-0.233	Koch-Weser, 1984
Karfiguéla (near Banfora)	10.689	-4.809	
Kaya	13.083	-1.083	SMF
Koumbia (Bobo Dioulasso)	11.233	-3.700	Adam & Hubert, 1976 [as from "Bobo-Dioulasso"]
Koutoura	10.350	-4.833	Koch-Weser, 1984; Bergmans, 1991
Koutoura (5 km SW)	10.317	-4.867	Koopman et al., 1978; Bergmans, 1988; Van Cakenberghe & De Vree, 1993; Van Cakenberghe & De Vree, 1998
Markoye	14.650	0.033	Koopman et al., 1978
Menegou	14.367	-0.283	Koch-Weser, 1984
Natiaboani	11.700	0.500	Koopman et al., 1978; Sakamoto et al., 1979; Robbins et al., 1985; Van Cakenberghe & De Vree, 1985; Bergmans, 1988; Van Cakenberghe & De Vree, 1985; Van Cakenberghe & De Vree, 1998; Csorba et al., 2003
Nayouré (3 km SE)	12.250	0.267	Koopman et al., 1978, Sakamoto et al., 1979; Van Cakenberghe & De Vree, 1985; Csorba et al., 2003
Nazinga [Forêt Classée de Nazinga]	11.167	-1.417	Bergmans, 1988
Nobéré (1 km S)	11.533	-1.200	Koopman et al., 1978; Van Cakenberghe & De Vree, 1993; Csorba et al., 2003
Nobéré (11 km S)	11.450	-1.200	Koopman et al., 1978
Nobéré (12 km S)	11.433	-1.200	Koopman et al., 1978
Nobéré (2 km S)	11.533	-1.200	Koopman et al., 1978
Nobere (9 mi S)	11.417	-1.200	Koopman et al., 1978; Van Cakenberghe & De Vree, 1985
Nouna)	12.733	-3.867	Kock, 1969; Koch-Weser, 1984; Kock et al., 2001
Orodara	10.983	-4.917	Koopman et al., 1978; Koch-Weser, 1984

Table 1/1. Gazetteer of previously records: data from publications and museums from 1964 to 1993 (continued).

Locality	Latitude	Longitude	Publications
Orodara (27 km ENE)	11.100	-4.683	Koopman et al., 1978; Van Cakenberghe & De Vree, 1985; Bergmans, 1989; Bergmans, 1997; Van Cakenberghe & De Vree, 1993; Van Cakenberghe & De Vree, 1998; Csorba et al., 2003
Ouagadougou	12.367	-1.517	Koopman et al., 1978, Koch-Weser 1984, Robbins et al., 1985, Bergmans 1988; Volleth, 1989; Volleth & Heller, 1994 ;Kock et al., 2001
Ougarou	12.150	0.933	Koopman et al., 1978; Robbins et al., 1985; Bergmans, 1988
Oulo	11.900	-2.983	Koopman et al., 1978; Van Cakenberghe & De Vree, 1993; Van Cakenberghe & De Vree, 1998
Oursi	14.683	-0.450	Koch-Weser, 1984; Aulagnier et al., 1987
Petoye	14.583	-0.367	Koopman et al., 1978; Koch-Weser, 1984; Robbins et al., 1985
Piyiri (7 km N) [= Pigahiri]	11.317	-1.133	Koopman et al., 1978
Pô-NP (Red Volta River)	11.333	-1.167	Koopman et al., 1978
Saba	14.717	-0.767	Koch-Weser, 1984; Van Cakenberghe & De Vree, 1994
Saouga	14.367	-0.150	Koch-Weser, 1984
Seguenega (6 km SE)	13.417	-1.933	Koopman et al., 1978
Sideradougou	10.667	-4.250	Koopman et al., 1978; Koch-Weser, 1984; Bergmans, 1988; Bergmans, 1989; Bergmans, 1991; Van Cakenberghe & De Vree, 1993
Sintao	13.717	-1.600	Koch-Weser, 1984
Soumouso	11.017	-4.050	Hervy & Legros, 1981a; 1981b
Takabougou	14.650	0.150	Koch-Weser, 1984
Tambao	14.800	0.083	Koch-Weser, 1984; Van Cakenberghe & De, Vree 1994
Tassamakot	14.350	-0.417	Koch-Weser, 1984
Tatarko	13.467	-0.317	Koopman et al., 1978; Koch-Weser, 1984; Van Cakenberghe & De Vree, 1998
Tazawat (Oursi) [= Tasamakot?]	14.350	-0.417	MNHN
Terhar	14.683	-0.867	Koch-Weser, 1984
Tin-A-kof	14.967	-0.167	Koch-Weser, 1984
Tin-Ediar	14.667	-0.567	Koch-Weser, 1984
Toni	12.650	-3.983	Koch-Weser, 1984
Tounté	14.650	-0.900	Koch-Weser, 1984
Voko	11.633	-1.267	Bergmans, 1991

Table 1/2. Gazetteer of previously records: data from publications and museums from 1964 to 1993.

Locality	Site	Latitude	Longitude	Date	# of nets	Total capture effort
Nazinon River (near)	along river	11.8200	-1.6733	17-18.4.2002	2	16
Djibo	near pond	14.1071	-1.6157	29.10.2004	1	5
Oursi	Near Oursi pond	14.6680	-0.4750	31.10 - 1.11.2004	2	6
Markoye	next to inselberg	14.6242	0.0432	3.11.2004	1	3,5
Karfiguêla (Comoé River, near Banfora)	gallery forest of Comoé riveré	10.6890	-4.8085	27.2.2005	1	4
Bama	orchard (pawpaw)	11.3974	-4.4022	1.3.2005	1	12
Dafra (gallery forest)	gallery forest	11.1102	-4.2505	1.12.2006	2	6
Hameau de Dafra (Koro village)	village	11.1000	-4.2333	1.12.2006	DR	
Dafra	near river & orchards	11.1083	-4.2500	3.12.2006	2	6
Cascade de Kou (Koro village)	forest	11.1523	-4.2072	4.12.2006	2	6
Kourouma (gallery forest)	dry forest close to gallery forest	11.6581	-4.7470	7.12.2006	2	24
Kourouma (village)	village	11.6159	-4.7992	9.12.2006	DR	
Toussiana (Banfora cliff)	gallery forest	10.8443	-4.5987	25.4.2008	2	6
Toussiana (near)	degraded gallery forest	10.8478	-4.6001	26.4.2008	1	3,5
Koba River (gallery forest, near Dounonso)		10.8466	-4.1075	30.4.2008	2	8
Koba River (savanna, near Dounonso)	savanna	10.8460	-4.1062	1.5.2008	2	15
10	16			17	23	121

Table 2. Sampling sites, dates of capture, number of nets used and capture effort made from 2002 to 2008. Capture effort = the number of hours during which a 12 m-net was open overnight; # of nets = number of nets used; DR = day roost.



Locality	Site	Latitude	Longitude	Description	Date	# of nets	Capture effort
F.C. & R.P.F. Comoé-Léraba	Site 1	9.9560	-4.6768	Folonzo village	21.4.2008	6	30
	Site 2	9.9323	-4.6085	near Comoé river	22.4.2008	4	48
	Site 3	9.9958	-4.8217	near termite mound	23.4.2008	5	60
	Site 4	9.8935	-4.7411	near water way	24.4.2008	5	48
	Site 5	9.7613	-4.5908	near dense forest at <i>Guibourtia copalifera</i>	25.4.2008	4	48
	Site 6	9.7043	-4.5866	near Confluent Comoé-Leraba	26.4.2008	4	96
F. C. Niangoloko	Site 1	10.2149	-4.9644	near road	28.4.2008	6	72
	Site 2	10.2427	-4.9118	in front of cave	29.4.2008	4	32
P.U. Bangr-Weoogo	Site 1	12.3975	-1.4891	near <i>Khaya senegalensis</i>	17.6.2008	4	32
	Site 2	12.3963	-1.4927	near pond	18.6.2008	4	30
	Site 3	12.3967	-1.4890	near pond	19.6.2008	2	24
F.C. Péni	Site 1	10.9437	-4.4776	near road	7.8.2008	2	12.5
	Site 2	10.9315	-4.4779	shrubby savanna	8.8.2008	4	20
	Site 3	10.9301	-4.4912	woodland	9.8.2008	5	55
R.B. Mare aux Hippopotames	Site 1	11.5624	-4.1222	shrubby savanna	11 – 12.8.2008	12	132
	Site 2	11.5435	-4.1053	woodland (near forest)	13.8.2008	6	66
	Site 3	11.5393	-4.1042	shrubby savanna(near forest)	14.8.2008	6	66
	Site 4	11.5460	-4.1041	dense forest	15.8.2008	6	66
F.C. Kou	Site 1	11.1828	-4.4427	woodland (near forest)	16 – 17.8.2008	8	72
	Site 2	11.1956	-4.4418	shrubby savanna (near forest)	18.8.2008	4	44
F.C. Niouma	Site 1	12.9228	-2.6798	shrubby savanna	30.10.2008	4	22
	Site 2	12.9363	-2.6880	clear forest	31.10.2008	6	45
	Site 3	12.9198	-2.6986	near pond	1.11.2008	6	54
F.C. Toessé	Site 1	12.7528	-2.3830	near pond	2.11.2008	5	40
	Site 2	12.7825	-2.3977	near stream	3.11.2008	6	46.5
	Site 3	12.7534	-2.3829	near pond	4.11.2008	4	31
F.C. Sa	Site 1	12.6537	-3.3201	shrubby savanna	24.11.2008	4	39.3
	Site 2	12.6329	-3.2664	gallery forest (except forest)	25.11.2008	6	52
	Site 3	12.6570	-3.3186	woodland (near river)	26.11.2008	6	45
F.C. Toroba		12.5120	-3.2236	gallery forest (near river)	28 – 29.11.2008	13	152.8
F.C. Kari	Site 1	12.4341	-3.1122	shrubby savanna	30.11.2008	4	36
	Site 2	12.4772	-3.1366	gallery forest (near river)	1 – 2.12.2008	15	180
F.C. Tissé		12.2487	-2.8692	gallery forest (near river)	3.12.2008	7	82.3
F.C. Oualou		12.3922	-2.8672	gallery forest	5.12.2008	8	46
Karfiguéla (Cascades de Banfora)	Site 1	10.7232	-4.8222	cave, hill, river	17 – 18.2.2009	14	47.5
	Site 2	10.7215	-4.8211	cave, hill, river	19.2.2009	7	10.5
Pics de Sindou		10.6535	-5.1536	herbaceous steppe with some woody	21.2.2009	7	21.9
Néguéni		10.6542	-5.3894	hill (along stream)	23.2.2009	4	3.5
	Cave 1	10.6545	-5.3890	hill, cave	23.2.2009	DR	
	Cave 2	10.6656	-5.4075	hill, cave	23.2.2009	DR	
Toussiana	Site 1	10.8466	-4.5978	gallery forest (along stream)	25.2.2009	5	15.5
	Site 2	10.8442	-4.5978	gallery forest, hill, stream	26.2.2009	4	9
	Site 3	10.8446	-4.5987	dense forest	27.2.2009	6	20
Galgouli	Site 1	9.9678	-3.4438	herbaceous steppe (along stream)	28.4.2009	7	29.8
	Site 2	9.9689	-3.3735	gallery forest (along stream)	29.4.2009	6	12.4
Loropéni	Site 1	10.3040	-3.4832	gallery	30.4.2009	4	20
	Site 2	10.3120	-3.5323	woodland (along dam)	1.5.2009	6	31.5
Batié	Site 1	9.8630	-2.9171	woodland (along dam)	2.5.2009	5	23.8
	Site 2	9.8771	-2.9336	woodland (rupicolous bar)	3.5.2009	4	18
Mouhoun River		9.5535	-2.7601	gallery forest (along river)	4.5.2009	5	25
F.C.Koulbi		9.6522	-2.8376	gallery forest (along river)	5.5.2009	6	25.5
Bambassou		9.9837	-2.9059	gallery forest (along river)	6.5.2009	6	31.5
Tikitiano		10.5570	-3.3130		7.5.2009	DR	
Parc National du W	Site 1	11.5160	2.0701	gallery forest	11.8.2009	5	11.3
	Site 2	11.5117	2.0723	gallery forest	12.8.2009	6	53.3
Chaîne de Gobnangou	Saboarkori 1	11.6720	1.5617	shrubby savanna (along mountain chain)	14.8.2009	7	38.5
	Saboarkori 2	11.6919	1.5842	woodland (along mountain chain)	15.8.2009	5	56.3
	Yirini	11.7354	1.6616	shrubby savanna (along mountain chain)	16.8.2009	6	33
	Yirini, cave	11.7105	1.6055	cave	17.8.2009	DR	
	Tindangou	11.6922	1.5842	cave	17.8.2009	DR	

Table 3/1. Sampling characteristics for the BIOTA project data collection from 2008 to 2009 (see below) (continued).

Locality	Site	Latitude	Longitude	Description	Date	# of nets	Capture effort
Diapaga		12.0765	1.7871		18.8.2009	DR	
Pama		11.3207	0.7241	woodland (near pond)	19.8.2009	4	22.5
Outourou	Site 1	10.6145	-5.4100	gallery (between hill)	18.9.2009	9	35
	Site 1	10.6086	-5.3094	gallery forest	19.9.2009	4	27.5
F.C. Lera	Site 2	10.5973	-5.3130	gallery forest	20.9.2009	8	24
	Site 3	10.5976	-5.3049	gallery forest	21.9.2009	8	22
	Site 1	10.7532	-5.2834	gallery forest	22.9.2009	8	40
Kankalaba	Site 2	10.7660	-5.3056	gallery forest	23.9.2009	9	42.5
	Site 3	10.7685	-5.3055	gallery forest	24.9.2009	8	39
	Site 1	10.6917	-5.0991	shrubby savanna (between dam and mountain)	27.9.2009	8	96
Niofila	Site 2	10.7095	-5.1162	woodland (near mountain)	28.9.2009	4	18
	Site 3	10.6859	-5.1270	forest	29.9.2009	9	108
<b>32</b>	<b>72</b>				<b>74</b>	<b>399</b>	<b>2937.3</b>

Table 3/2. Sampling characteristics for the BIOTA project data collection from 2008 to 2009 (sampling sites, capture dates, number of nets used and capture effort). F.C.: Protected forest; R.P.F.: Partial wildlife reserve; P.U.: Urban park; B.R.: Biosphere reserve; DR: day roost. # of nets = number of nets. Capture effort = number of hours during which a net of 12 m is open overnight (i.e. this number is divided by two for a 6m-net).

the various areas, for the preparation of measurement Tables and reference collections of the University of Ouagadougou.

Body measurement (accuracy 0.1 mm) and cranial measurements (accuracy 0.01 mm) were conducted on these specimens. The cranial measurements are performed under a binocular magnifying glass branded Leica MZ8. Body measurements are: HB (head and body length from tip of snout to posterior margin of anus); Tail (length of tail from posterior margin of anus to tip of tail); Tot (total length, HB + Tail); Ear (length of ear from lower margin of conch to tip of ear); Trag (length of tragus along posterior margin from base to tip); FA (length of forearm including carpals); 3Met (length of metacarpal of third digit, excluding carpals); 3Ph1 (length of first phalanx of third digit); 3Ph2 (length of second phalanx of third digit); 3Ph3 (length of third phalanx of third digit); 4Met (length of metacarpal of fourth digit, excluding carpals); 4Ph1 (length of first phalanx of fourth digit); 4Ph2 (length of second phalanx of third digit); 5Met (length of metacarpal of fifth digit, excluding carpals); 5Ph1 (length of first phalanx of fifth digit); 5Ph2 (length of second phalanx of fifth digit); Tib: length of tibia; HF (length of hind foot, including claws). Cranial measurements are: C-C - width across crowns of upper canines, Mn-Mn - width across crowns of posterior upper molars, C-Mn - length of upper (maxillary) tooth row from front of canine to back of posterior molar.

### *Mapping of species distribution*

To develop distribution maps of each species across the country, the Quantum GIS 1.8.0 software was used. Country limits and phytogeographic areas according to Fontès & Guinko (1995) were also used. These information were used in Quantum GIS 1.8.0 to produce a background map. On this map, we added thereafter, for each species, the locations where species was recorded (captured or observed).

## RESULTS

Data collected between 1964 and 1993 include 1,669 specimens belonging to 36 species, collected at 77 sites.

Recent data (between 2002 and 2009) were collected during two phases; between April 2002 and May 2008 at 16 sites with 172 specimens belonging to 17 species identified; and between April 2008 and September 2009 (72 sites) with 1,639 specimens belonging to 45 species identified.

The combination of previously and recent data represent 164 sites with a total of 3,480 specimens examined. Their total give 51 species derived from the 46 years of observation. These 51 species were spread over 24 genera and 9 families, including one frugivorous and 8 insectivorous families. Insectivorous have greater species diversity com-



pared to frugivorous. Frugivorous have 7 species in a single family, Pteropodidae and Insectivorous have 44 species distributed into 8 families: Hipposideridae (7), Megadermatidae (1), Rhinolophidae (3), Rhinopomatidae (2), Emballonuridae (3), Nycteridae (5), Molossidae (6) and Vespertilionidae (17).

#### Family PTEROPODIDAE

Genus *Eidolon* Rafinesque, 1815

*Eidolon helvum* (Kerr, 1792)

This species is found in almost all phytogeographic zones of Burkina Faso (Fig. 2). It is a migratory species (Thomas, 1983; Richter & Cumming, 2008; Ossa et al., 2012). *Eidolon helvum* moves from the forest zone during the wet season to northern woodlands and savannas, and may even reach the edge of the desert (Horáček et al., 2000). It forms colonies of thousands of individuals, which are frequently located near cities or villages. From 2009 to 2014 each year a large colony roosts in the urban park Bangr-Weoogo in downtown Ouagadougou. Some individuals have been observed during the month of May in the Southwest in the village of Tikitiana but the entire colony had not yet arrived. Another colony was also observed in August in the city of Diapaga in the Southeast.

Genus *Epomophorus* Bennett, 1836

*Epomophorus gambianus* (Ogilby, 1835)

*Epomophorus gambianus* is widely distributed in the Sudanian zone of Burkina Faso, though with fewer localities in the northern part (Fig. 2). The species is commonly found in West Africa and widely distributed in both Guinean and Sudanian savannas while only a few specimens have been found in the Sahelian zone. The latter zone with Acacia and deciduous shrubs seems to represent the northern limit of the species (Boulay & Robbins, 1989).

Genus *Hypsignathus* Allen, 1861

*Hypsignathus monstrosus* H. Allen, 1862

*Hypsignathus monstrosus* has been recorded from the southwest of the South-Sudanian area (Fig. 2). This species is mainly found in the forest

zone, but extends into savannas along gallery forests and forest islands (Bergmans, 1989; Fahr et al., 2006). As such, localities in southern Burkina Faso are probably near its range northern limit (Koopman et al., 1978).

Genus *Lissonycteris* K. Andersen, 1912

*Lissonycteris angolensis* (Bocage, 1898)

This species occurs in the southwestern part of Burkina Faso (Fig. 2). Its presence is probably due to the fact that it is a species extending from the forest areas of West Africa to the wet savannas. In this part of the country, *Lissonycteris angolensis* is mainly found in hilly areas and cliffs that provide suitable day roosts such as caves and rock overhangs. We located several day roosts in the cliffs of Banfora.

Genus *Micropteropus* Matschie, 1899

*Micropteropus pusillus* (Peters, 1868)

*Micropteropus pusillus* is less widely distributed in Burkina Faso than *Epomophorus gambianus*, with most records from woodlands of the Sudanian zone and only few records in the North-Sudanian area (Fig. 2). Although this species ranges up to 14°N in West Africa (Owen-Ashley & Wilson, 1998), no specimens have been captured so far in the Sahelian area of Burkina Faso.

Genus *Nanonycteris* Matschie, 1899

*Nanonycteris veldkampii* (Jentink, 1888)

*Nanonycteris veldkampii* was captured in the Sudanian zone (Fig. 2). This species migrates during the wet season from the forest zone to the northern Sudanian zone (Thomas, 1983). In agreement with this, all captures were made during the wet season in protected forests, gallery forests along Gobnangou range and next to water points.

Averages of body measurements (except Ear, Tib, and HF) and cranial measurements of males are smaller than the measurements of females. The maximum measurements of the forearm and wings and the cranial measurement (MM) of males are lower than the minimum measurements of females (Table 4). The wings of females are longer than those of males.

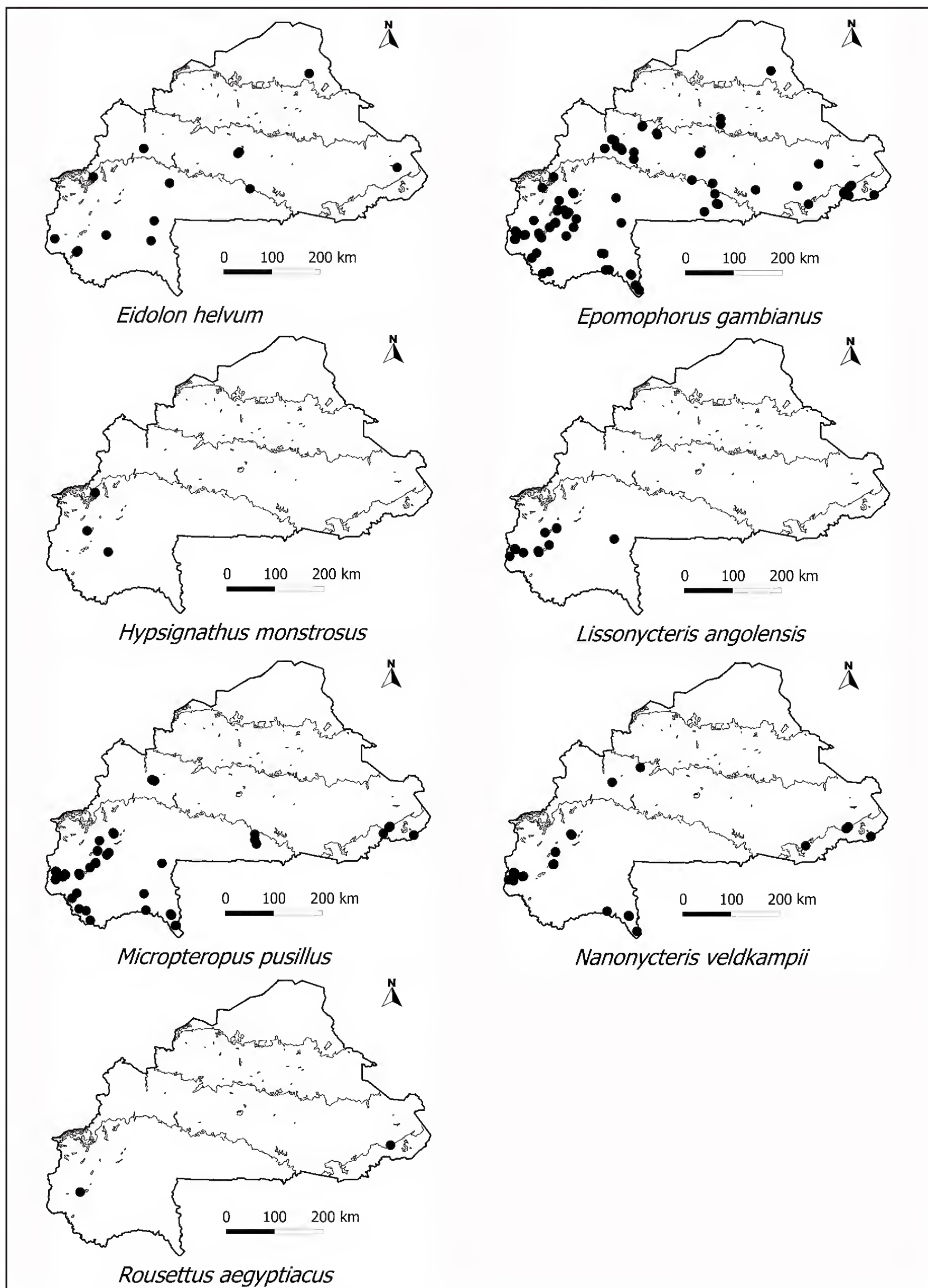


Figure 2. Distribution of Pteropodidae in Burkina Faso.



Eidolon helvum																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂		258.0		24.7	27.6		115.2	81.0	50.1	83.2		79.9	39.7	52.3	68.5	33.0	36.0	49.6	28.4	10.45	17.23	21.90
Epomophorus gambianus																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	127.8	138.1	6.8	27.6		89.7	65.9	40.5	53.7		62.6	30.7	32.7	63.3	30.5	30.4	39.3	21.0	10.14	14.09	21.13
	Min	120.0	127.5	4.6	26.4		88.8	64.7	39.6	49.6		61.8	29.2	30.2	62.2	28.9	29.0	37.8	20.1	9.97	13.77	20.26
	Max	144.0	143.7	9.3	29.6		92.1	67.1	41.7	56.5		63.4	31.3	34.2	64.0	31.2	31.9	40.5	21.7	10.49	14.65	21.80
	n=	4	4	4	4		4	4	4	4		4	4	4	4	4	4	4	4	4	4	4
♀♀	X	87.5	132.2	8.3	26.7		86.1	64.0	40.0	51.9		60.8	29.6	32.5	61.8	30.2	29.1	36.9	20.7	9.57	13.74	19.92
	Min	64.0	125.6	6.0	25.2		84.0	61.2	39.1	50.3		58.4	27.3	31.3	59.5	29.0	27.9	36.2	19.6	9.27	13.29	18.64
	Max	112.0	137.8	10.1	28.3		88.7	66.5	41.1	53.1		63.4	31.5	33.5	63.3	31.9	30.2	37.4	22.3	9.79	14.57	20.84
	n=	4	4	4	4		4	4	4	4		4	4	4	4	4	4	4	4	4	4	4
Lissonycteris angolensis																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♀	X	55.0	104.2	13.1	20.8		69.6	50.6	34.8	42.0		49.0	26.0	27.2	47.9	22.6	24.5	30.0	19.9	7.44	10.84	13.81
	± SD	4.1	6.8	1.0	1.0		2.8	2.1	1.7	2.1		1.8	1.2	1.0	1.8	1.0	1.4	1.3	1.6	0.22	0.52	0.69
	Min	46.0	98.3	11.2	19.1		66.3	47.9	32.3	39.4		46.1	24.1	25.7	45.0	20.5	22.0	27.9	18.1	7.16	10.19	13.11
	Max	58.0	119.5	14.2	22.3		73.3	55.1	38.0	45.7		51.8	27.7	29.1	50.6	23.8	26.2	32.0	23.0	7.74	11.76	14.87
	n=	6	7	7	7		7	7	7	7		7	7	7	7	7	7	7	7	5	6	6
Micropteropus pusillus																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	29.8	78.2	7.9	16.3		51.9	38.6	23.7	31.4		38.1	17.4	20.3	37.5	17.6	18.5	22.7	13.3	6.16	10.03	9.14
	± SD	2.6	4.0	0.9	0.6		1.1	1.3	0.6	1.4		1.1	0.5	0.7	0.9	0.5	0.9	0.5	0.7	0.21	0.39	0.39
	Min	27.0	72.9	6.9	15.4		50.2	36.4	22.7	28.8		36.2	16.6	19.3	36.0	16.7	17.0	22.2	11.9	5.80	9.40	8.42
	Max	34.0	84.2	9.0	16.9		53.2	40.1	24.6	32.6		39.5	18.1	21.4	38.5	18.2	19.7	23.2	13.9	6.46	10.60	9.50
	n=	5	5	5	5		5	5	5	5		5	5	5	5	5	5	5	5	5	5	5
♀♀	X	25.6	77.1	7.3	16.7		51.3	37.7	24.1	31.8		37.4	17.4	20.2	36.5	17.5	18.3	21.7	13.6	5.93	9.25	8.63
	Min	21.0	71.7	6.4	15.8		49.3	36.7	23.0	29.5		36.0	16.7	19.4	34.7	17.1	17.8	20.9	13.3	5.61	8.86	8.22
	Max	34.0	82.4	8.3	17.7		54.2	39.1	25.6	32.5		39.1	18.9	21.2	37.9	18.2	19.0	23.2	14.0	6.09	9.90	9.29
	n=	5	4	4	4		4	4	4	4		4	4	4	4	4	4	4	4	4	4	4
Nanonycteris veldkampii																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	19.4	67.3	5.6	16.3		46.7	34.5	22.0	28.0		33.6	16.1	17.9	33.8	15.3	15.3	19.0	12.7	5.03	6.95	7.13
	± SD	3.1	4.2	1.0	1.0		1.3	1.0	0.9	1.8		1.1	0.7	0.9	1.3	0.8	0.8	0.9	0.4	0.16	0.21	0.21
	Min	15.0	61.9	3.9	14.7		45.4	32.4	21.1	25.7		31.6	15.2	16.3	31.7	14.2	14.2	18.0	11.9	4.87	6.64	6.86
	Max	26.0	76.3	6.7	17.7		48.9	35.8	23.7	30.9		35.0	17.1	19.2	36.2	16.8	16.8	20.6	13.2	5.31	7.22	7.54
	n=	8	8	8	8		8	8	8	8		8	8	8	8	8	8	8	8	7	7	7
♀		28.0	74.9	7.3	17.4		54.5	41.8	26.4	34.1		40.7	18.4	19.6	40.8	17.8	18.0	22.6	13.0	5.46	7.26	7.68
♀		21.0	69.1	5.8	15.8		50.8	39.4	24.5	31.9		37.3	17.9	19.7	37.5	17.3	17.5	18.9	12.7	5.31	7.34	7.36
Rousettus aegyptiacus																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	144.8	136.1	22.1	21.7		98.0	64.8	42.4	58.3		63.0	33.6	36.8	60.7	30.9	28.3	45.1	26.0	9.41	13.50	17.29
	Min	130.0	133.6	18.0	20.9		93.5	63.0	41.9	54.6		61.0	32.3	36.0	58.3	30.7	28.1	42.8	20.0	8.93	13.28	16.86
	Max	162.0	139.7	26.2	22.5		101.3	66.3	42.9	60.5		64.3	35.7	37.7	62.6	31.1	28.4	48.0	30.2	10.12	13.63	17.65
	n=	4	3	4	4		4	3	3	3		3	3	3	3	3	3	4	4	4	4	4

Table 4. Measurements of Pteropodidae from Burkina Faso.

Genus Rousettus Gray, 1821

Rousettus aegyptiacus (E. Geoffroy, 1810)

Rousettus aegyptiacus was recorded from the western and eastern part of the South-Sudanian zone (Fig. 2). In the Sudanian zone, R. aegyptiacus has been captured in rocky formations that provide a wide variety of day roosts for this cave-dwelling species (Hayman, 1967; Qumsiyeh, 1985). Indeed, several specimens have been captured in the cliffs of Banfora where their shelters have been observed and where one of the caves contained about 500 to 2000 individuals. Two other specimens have been captured along Gobnangou range.

It looks like Lissonycteris angolensis but the averages of body measurements (except Ear, HF)

and cranial measurements of L. angolensis are lower than those of R. aegyptiacus. In addition, maximum measurements (except Ear, HF) of L. angolensis are below the minimum measurements of R. aegyptiacus (Table 4).

Family HIPPOSIDERIDAE

Genus Asellia Gray, 1838

Asellia tridens (E. Geoffroy, 1813)

Asellia tridens is particularly found in North and Northeast Africa (Hayman, 1967; Horáček et al., 2000). This desert species extends into the North-Saharan zone of Burkina Faso (Fig. 3), which is probably its southern limit.

Genus *Hipposideros* Gray, 1831

*Hipposideros abae* J. A. Allen, 1917

*Hipposideros abae* is known in forest areas as well as in woody savannas (Aellen, 1952). According to Koopman et al. (1978), it probably reaches its Northern limit in Burkina Faso. Indeed, all specimens are located only in the Southwest in the South-Sudanian zone (Fig. 3). Most specimens captured during the BIOTA collect come from a cave where *H. tephros*, *H. ruber*, *Nycteris macrotis* and *Rhinolophus landeri* were also captured. *Hipposideros abae* is known to present two color phases, gray and red, like the other members of the family (Rosevear, 1965). However, all specimens captured during the late BIOTA collect were shows almost the same orange-yellow color except one specimen captured at Kankalaba which shows a darker color tending towards red.

Males are not different from females (Table 5)

*Hipposideros cyclops* (Temminck, 1853)

*Hipposideros cyclops* is located in the extreme Southwest in the South-Sudanian zone (Fig. 3). All three specimens have been captured in the protected forest and partial wildlife reserve of Comoé-Léraba, next to a dense forest at Guibourtia copalifera and not far from the Comoé-Léraba confluence. This forest species (Rosevear, 1965) is common in the gallery forests and forest islands of the National Park of Comoé in Ivory Coast. However, it extends from forests into savannas (Fahr, 1996). It would therefore be extended into this part of Burkina Faso near the Ivorian border. The number of our specimens does not allow us to conclude a sexual dimorphism (Table 5). However, sexual dimorphism is pronounced, with females being larger than males (Decher & Fahr, 2005).

*Hipposideros jonesi* Hayman, 1947

This species has been found in the southwest (Sudanian zone) of the country and in the extreme southeast of the South-Sudanian zone (Fig. 3). One orange-yellow phase was observed on the captured specimens.

*Hipposideros ruber* (Noack, 1893)

*Hipposideros ruber* is widely distributed and is

located in all phytogeographic areas (Fig. 3). It is more common in the South being gradually rare towards the North. The specimens have been captured in an arborous savanna along a rupicolous bar in a mountain range, at the entrance to a cave, in a gallery forest, the cliffs of Banfora, a wooded savanna along a dam, a shrubby savanna between a mountain and a dam, a wooded savanna near a mountain and a cave, and in a wooded savanna next to a managed water point near the Nazinon river and not far from a water point. The captured specimens showed two phases of color: some were brown and others orange-yellow. The cytochrome b from several specimens has been sequenced by CBGP (J.-F. Cosson & S. Chollet, unpubl. data). According to these data, two specimens from Dafra, one specimen from Djibo and one specimen from Koba River belong to clade D1 as designated by Vallo et al. (2009), while seven specimens from Toussiana belong to clade C1. Twenty-two individuals (2 males, 19 females, 1 unsexed, none sequenced) from Toussiana, site 1, called at  $140.8 \pm 1.0$  (138.5-142.3) kHz. One male from Karfiguéla called at 140.2 kHz.

*Hipposideros tephros* Cabrera, 1906

It is located in the West and South of the country (Fig. 3). It is present in all phytogeographic zones except in the North-Sahelian one. A specimen has been captured in a forest at the entrance to a cave where *Hipposideros abae*, *H. ruber*, *Nycteris macrotis* and *Rhinolophus landeri* live together. The other specimens have been captured in a pocket of forest on a rocky substratum rich in *Raphia* palm and next to the Nazinon River. All specimens that we captured were presenting a single orange-yellow phase.

*Hipposideros tephros* is smaller than *H. ruber*. The averages of body measurements and cranial measurements of *H. tephros* are lower than those of *H. ruber*. However, there is an overlap on all body measurements (except HB). Nevertheless, cranial measurements reveal that the maximum values of *H. tephros* are smaller than the minimum values of *H. ruber* (Table 5). A specimen from waterfalls of Kou is member of clade A2 following the designation adopted by Vallo et al. (2009), which should be named *H. tephros*.

*Hipposideros vittatus* (Peters, 1852)

It is the largest of Hipposideridae among those



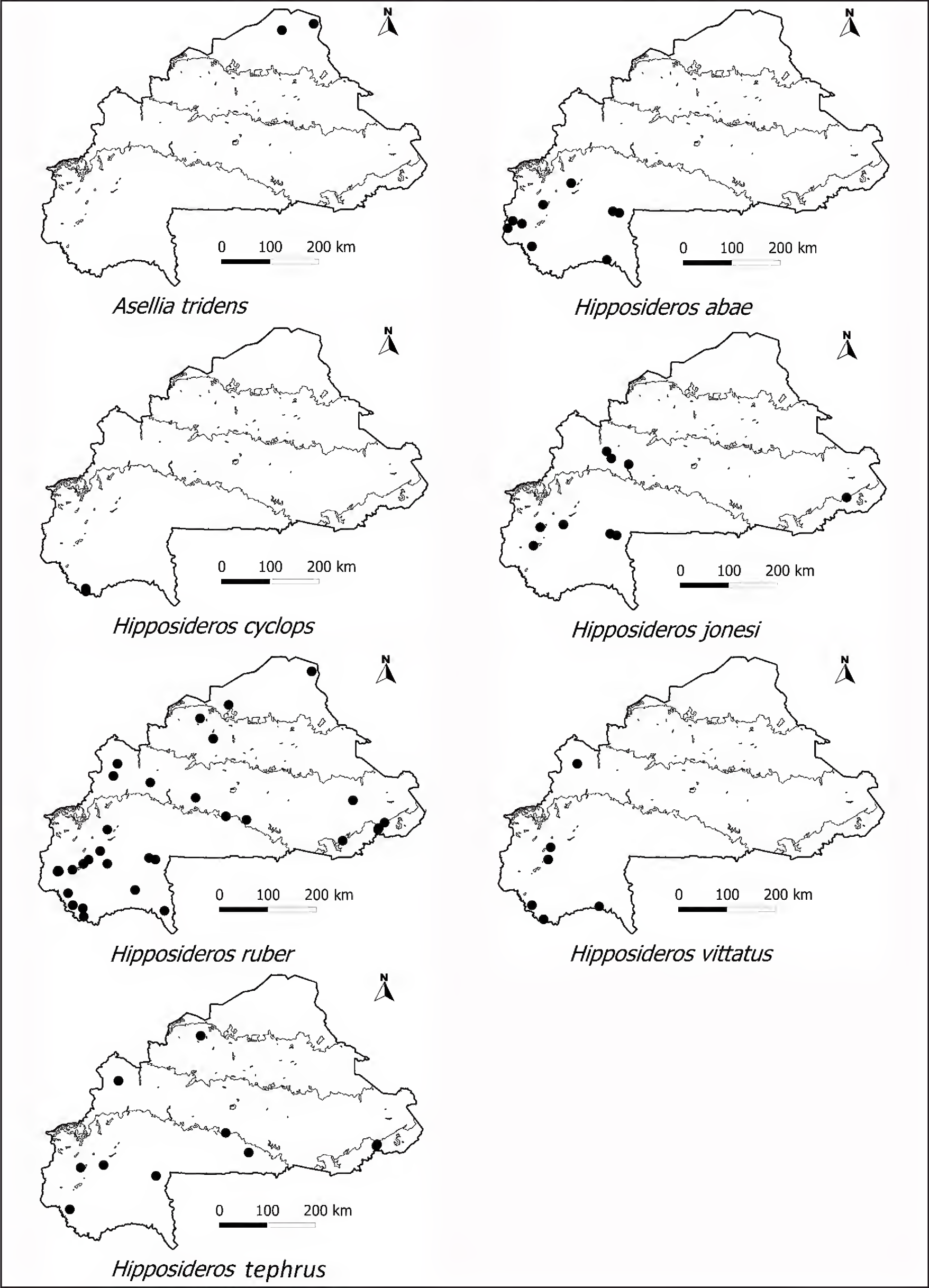


Figure 3. Distribution of Hipposideridae in Burkina Faso.

found in Burkina Faso (see Table 5). Present in branches of trees as well as in caves (Pye, 1972; Vaughan, 1977), it is located west of the Sudanian zone (Fig. 3). The specimens have been captured in woodland, next to a gallery forest, in a shrubby and arborous savanna and in an herbaceous steppe located along a river.

Body measurements show that males are not different from females. On the other hand, the maximum values of cranial measurements of females are lower than the cranial measurements of males (Table 4). All captured specimens were yellow.

#### Family MEGADERMATIDAE

Genus *Lavia* Gray, 1838

*Lavia frons* (E. Geoffroy, 1810)

This species is found in savannas and semi-wooded areas (Vaughan & Vaughan, 1986) but not widely distributed in Burkina Faso, where it has been recorded from a few areas in the southern part of the country (Fig. 4). In eastern Kenya, it regularly roosts in thorny *Acacia* trees (Vaughan & Vaughan, 1986; Vaughan, 1987); hence it is surprising that there are no records from northern Burkina Faso. Some specimens have been captured near water points.

Males are not really different from females. Body measurements and cranial measurements do not enable to separate them (Table 6).

#### Family RHINOLOPHIDAE

Genus *Rhinolophus* Lacépède, 1799

*Rhinolophus alcyone* Temminck, 1853

*Rhinolophus alcyone* was distributed in the extreme southwest of the South-Sudanian zone (Fig. 5). In Burkina Faso, this forest species probably depends on gallery forests that provide similar conditions to rainforests further south. All captured specimens were gray, resembling that of *R. fumigatus*.

Averages of body measurements (except 3Ph1, 5Ph2, Tib and HB) and cranial measurements of males from *R. alcyone* are smaller than those of males from *R. fumigatus*. Only the maximum value of the ear of males from *R. alcyone* species is less than the minimum value of the ear of males from

*R. fumigatus*. And the minimum value of the tibia of *R. alcyone* is higher than the maximum value of the tibia of *R. fumigatus*. All other values are not distinctly separated. As regards females, all values (except 5Ph2) of *R. alcyone* are smaller than the averages of *R. fumigatus*. Moreover, all values (except HB, Tail, 3Ph1, 5Ph2 and Tib) of *R. alcyone* are smaller than the minimum values of *R. fumigatus* (Table 7).

#### *Rhinolophus fumigatus* Rüppell, 1842

In Burkina Faso, *Rhinolophus fumigatus* has been recorded in the Sudanian zone, with several localities in the north of the South-Sudanian zone and few localities in the western North-Sudanian zone (Fig. 5). *Rhinolophus fumigatus* is present in more open habitats than *R. alcyone* (Rosevear, 1965), which explains its wider distribution in Burkina Faso than *R. alcyone*. Like *R. landeri*, *R. fumigatus* does not live only in caves. According to Koopman et al. (1978), they were captured in huts. Some specimens were observed during the BIOTA collect in a large rock cleft in the Gobnangou range.

Five males called at  $54.2 \pm 0.4$  (53.4-54.4) kHz. Two collected specimens had a horseshoe width of 11.3 and 11.5 mm, respectively. Averages of body measurements do not help to distinguish males from females. On the other hand, the averages of cranial measurements of males are higher than those of females (Table 7).

#### *Rhinolophus landeri* Martin, 1838

*Rhinolophus landeri* occurs in almost all phyto-geographic zones of Burkina Faso except in the North-Sahelian zone (Fig. 5). Day roosts are caves, house of worship, bridges, and wells (Aellen, 1952; Menzies, 1973; Koopman et al., 1978; Kock et al., 2002), and the dependency on cave-like structures might explain the concentration of records in the southwest of the country, with its numerous rocky formations. The ability to roost in environments other than caves might explain its presence in other parts of the country, and this species probably occurs throughout most of Burkina Faso. It would therefore not be surprising to find it almost everywhere in Burkina Faso, particularly in rock formations in the South-East. Most specimens have been



Hipposideros abae																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	Tib	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	14.7	63.0	32.4	20.8		59.7	41.9	18.4	19.6		40.8	12.3	10.4	36.8	15.3	11.4	24.3	10.9	5.98	8.93	8.76
	± SD	1.0	1.6	2.1	1.0		1.5	1.1	0.7	1.1		1.3	0.5	0.6	1.0	0.5	0.6	0.7	0.4	0.15	0.15	0.15
	Min	12.0	58.9	27.5	19.1		56.7	39.5	16.9	17.4		37.7	11.0	9.2	34.9	14.2	10.7	22.8	9.6	5.77	8.66	8.53
	Max	17.5	65.2	36.3	22.5		62.6	43.9	19.5	21.9		44.4	13.3	11.8	39.8	16.5	12.7	25.6	11.6	6.44	9.16	9.11
	n=	25	25	25	25		18	25	25	25		25	25	25	25	25	25	25	25	24	25	24
♀♀	X	18.0	61.8	31.7	20.4		60.1	44.1	18.9	20.6		42.9	13.0	10.8	38.9	15.4	12.0	24.6	10.5	5.92	8.99	8.76
	± SD	4.3	3.6	1.3	0.9		2.3	1.4	0.8	1.0		1.8	0.6	0.8	1.1	0.7	0.8	1.1	0.6	0.13	0.17	0.15
	Min	13.0	57.4	30.2	19.1		56.4	42.6	17.9	19.1		41.0	12.1	9.5	37.8	14.7	10.4	23.3	9.1	5.74	8.78	8.53
	Max	26.3	69.0	34.0	21.7		63.0	47.3	20.1	22.4		46.6	13.9	11.6	41.2	16.4	12.8	26.6	11.3	6.11	9.36	9.03
	n=	7	7	7	7		7	7	7	7		7	7	7	7	7	7	7	7	7	7	7
Hipposideros cyclops																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	Tib	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂		34.0	77.5	25.7	32.8		70.1	55.5	20.1	27.4		57.4	14.2	14.2	55.5	16.5	15.0	30.4	17.5	8.01	11.27	9.80
♀		49.0	75.4	29.5	32.1		70.3	59.7	21.2	27.2		59.2	15.8	15.0	57.6	18.2	15.4	35.9	18.3	7.80	11.25	10.29
♀		44.0	76.9	29.5	30.9		70.6	56.7	21.0	22.2		59.3	14.7	15.2	57.5	16.5	14.5	35.8	17.9	7.78	10.70	10.00
Hipposideros jonesi																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	Tib	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	7.2	48.9	23.2	23.4		46.7	34.0	14.7	16.9		35.8	10.9	8.7	32.8	12.3	10.1	21.7	7.8	3.68	5.83	5.93
	± SD	0.3	2.5	2.7	1.4		0.8	0.6	0.5	0.8		0.7	0.4	0.5	0.9	0.4	0.3	0.9	0.3	0.12	0.16	0.09
	Min	7.0	46.2	17.8	21.6		44.9	33.1	14.2	15.5		34.5	9.9	8.0	31.6	11.8	9.6	20.3	7.3	3.48	5.63	5.82
	Max	8.0	54.5	26.4	25.2		47.3	34.8	15.8	17.6		36.5	11.2	9.2	34.1	12.8	10.5	22.8	8.2	3.84	6.03	6.07
	n=	7	7	7	7		7	7	7	7		7	7	7	7	7	7	7	7	7	7	7
♀		6.0	43.7	22.6	20.5		44.4	32.2	14.5	15.8		33.9	10.0	8.2	31.6	11.9	9.5	20.2	7.2	3.27	5.50	5.68
Hipposideros ruber																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	Tib	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♀	X	9.9	52.1	30.0	15.7		49.1	37.2	16.2	16.3		36.2	11.2	9.1	32.7	13.9	9.9	20.6	9.0	4.90	7.20	7.03
	± SD	1.3	2.1	3.2	0.9		1.3	1.9	0.7	1.0		2.3	0.5	0.6	1.7	0.5	0.5	0.8	0.6	0.25	0.23	0.19
	Min	7.0	48.0	23.0	13.4		46.5	33.6	14.8	14.1		32.0	10.2	7.7	29.6	12.9	9.1	19.0	7.8	4.29	6.58	6.66
	Max	13.5	58.3	38.8	17.6		52.4	41.4	17.7	18.4		41.9	12.1	10.2	36.3	14.8	11.0	22.7	10.8	5.26	7.80	7.44
	n=	48	48	48	48		97	48	48	48		48	48	48	48	48	48	90	88	74	89	89
Hipposideros vittatus																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	Tib	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂		82.0	104.	37.4	30.4		109.	81.0	37.5	44.5		78.1	28.8	16.6	78.7	29.4	18.4	45.8	22.2	10.93	13.52	13.36
♂		120.0	109.	32.2	29.7		102.	77.2	34.8	39.8		75.5	28.8	16.2	73.2	28.8	15.8	43.0	20.9	11.16	13.68	13.32
♀♀	X	77.0	99.9	33.1	27.6		96.5	70.9	32.4	38.9		69.5	26.6	15.4	68.3	27.3	16.6	38.8	20.0	9.86	12.80	12.47
	± SD	9.0	2.9	4.0	1.3		2.9	2.3	1.0	2.1		2.2	1.1	0.8	2.4	1.4	0.9	1.1	1.2	0.10	0.30	0.22
	Min	63.0	96.4	26.0	25.4		93.6	67.7	30.6	36.0		66.0	25.2	14.3	65.5	25.4	15.1	37.3	18.5	9.73	12.30	12.17
	Max	93.0	104.	38.4	29.7		102.	74.7	33.9	42.0		72.6	28.9	16.5	73.0	30.1	17.8	40.9	21.7	10.00	13.16	12.91
	n=	7	7	7	7		7	7	7	7		7	7	7	7	7	7	7	7	7	7	7
Hipposideros tephrus																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	Tib	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♀	X	6.3	45.2	28.6	13.3		44.9	33.3	14.6	15.8		33.0	9.9	8.8	29.3	12.5	10.2	18.2	7.9	3.67	5.68	5.57
	± SD		1.1	2.2	0.5		1.2	1.0	0.5	0.5		1.0	0.3	0.4	1.2	0.4	0.4	0.7	0.4	0.10	0.14	0.09
	Min	5.5	43.6	25.2	12.9		42.0	32.0	13.9	15.2		31.9	9.6	8.0	28.1	11.9	9.6	16.9	7.1	3.48	5.36	5.31
	Max	7.0	46.8	31.2	14.2		47.0	35.1	15.3	16.6		35.0	10.4	9.2	31.7	13.0	10.8	19.4	8.6	3.84	5.91	5.70
	n=	2	6	6	6		21	6	6	6		6	6	6	6	6	6	22	7	16	17	18

Table 5. Measurements of Hipposideridae from Burkina Faso.

<i>Lavia frons</i>																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂	23.5	66.7		40.1	25.1	61.6	45.7	25.5	39.4		48.9	16.1	14.1	51.8	16.8	16.5	34.4	16.5	5.85	8.86	9.47	
♂	22.3	69.1		43.6	23.4	60.8	44.6	24.0	40.5		47.8	16.0	15.5	50.7	16.6	15.9	33.8	16.8	5.87	9.18	8.67	
♀♀	X	28.5	70.2		42.8	26.5	61.3	45.7	25.4	42.1		49.8	15.9	14.9	52.1	17.2	16.7	34.5	16.7	6.25	9.09	9.23
	Min	26.3	66.0		41.8	25.1	60.0	45.1	25.1	41.3		49.5	14.4	14.6	51.4	16.7	16.6	33.7	15.5	6.22	8.74	9.05
	Max	31.0	74.2		44.3	28.0	62.3	46.3	25.8	42.7		50.4	17.4	15.2	53.1	17.9	16.8	35.1	17.2	6.28	9.44	9.40
	n=	3	4		4	4	4	4	4	4		4	4	4	4	4	4	4	4	2	2	2

Table 6. Measurements of Megadermatidae from Burkina Faso.

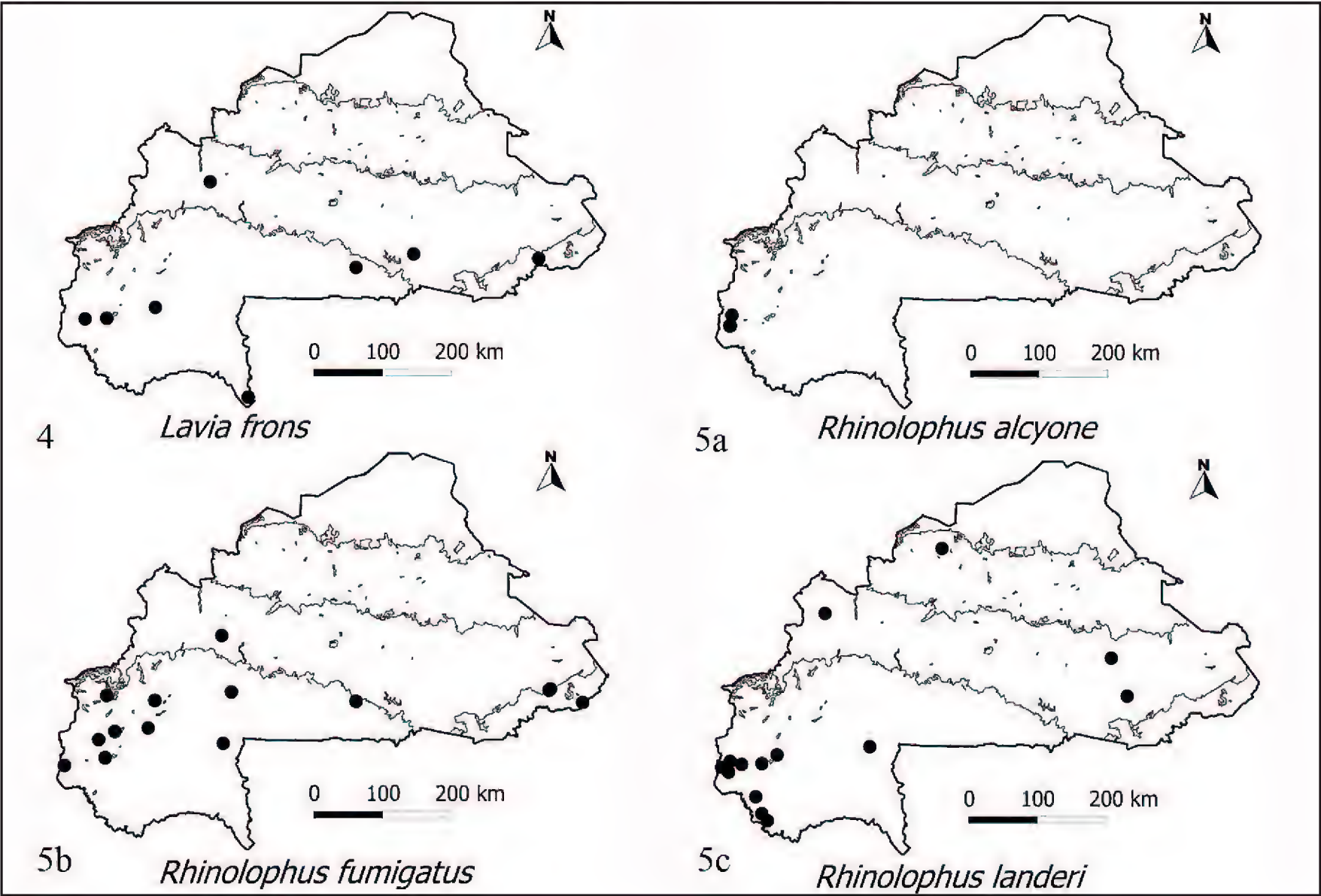


Figure 4. Distribution of Megadermatidae in Burkina Faso. Figure 5. Distribution of Rhinolophidae in Burkina Faso.

Rhinolophus alcyone																				
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C
♂♂	X	13.1	56.7	26.3	19.8		50.4	36.6	17.4	26.6	2.7	41.6	8.8	16.4	40.1	11.9	14.9	23.6	12.1	6.31
	Min	12.0	55.5	22.8	19.7		49.5	35.1	16.9	24.6	2.7	41.0	8.0	15.2	39.2	11.4	14.2	23.2	11.4	6.01
	Max	14.0	57.6	30.6	19.9		51.1	38.0	18.1	28.2	2.8	42.5	9.3	17.3	42.1	12.3	15.6	24.4	13.0	6.50
	n=	4	4	4	4		4	4	4	4	4	4	4	4	4	4	4	4	4	4
♀		12.0	54.8	25.4	20.2		48.8	35.7	16.3	26.7	2.7	40.4	8.4	15.2	40.2	11.8	13.8	22.5	10.5	5.47
Rhinolophus fumigatus																				
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C
♂♂	X	16.1	64.2	27.0	24.4		53.4	39.4	17.0	29.4	3.1	41.9	10.3	17.8	42.5	13.1	14.2	21.6	11.6	6.79
	± SD	1.6	5.4	2.4	1.8		1.5	1.0	0.7	1.4	0.3	1.0	0.7	0.9	0.9	0.7	1.2	1.3	1.0	0.29
	Min	12.0	57.0	23.3	21.7		50.4	37.5	16.2	26.3	2.5	39.9	9.3	16.3	40.7	11.8	12.8	18.6	10.1	6.26
	Max	17.5	74.6	31.0	27.0		55.4	40.5	18.3	30.9	3.5	43.3	11.5	19.2	43.7	14.1	16.2	22.9	13.6	7.24
	n=	9	9	9	9		9	8	8	8	5	8	8	8	8	8	8	8	9	6
♀♀	X	15.2	60.6	28.0	24.3		53.0	39.5	16.4	28.5	3.4	42.3	10.0	17.8	42.7	12.7	13.7	22.3	11.1	6.64
	Min	10.0	57.0	23.5	22.9		50.3	38.5	15.7	27.8	3.2	41.8	9.9	17.0	42.4	12.3	13.5	22.0	10.7	6.43
	Max	18.0	67.0	34.0	25.0		55.7	40.4	17.1	29.2	3.6	42.7	10.1	18.5	42.9	13.0	13.9	22.5	12.0	6.80
	n=	4	4	4	4		4	2	2	2	2	2	2	2	2	2	2	2	4	3
Rhinolophus landeri																				
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C
♂♂	X	5.9	45.3	23.4	17.1		41.4	28.4	12.8	19.2		31.7	6.4	11.9	30.6	9.0	11.6	17.9	8.4	4.72
	± SD	0.6	3.8	1.8	0.8		1.5	1.3	0.4	1.9		1.9	0.4	1.2	2.0	0.4	0.7	0.6	0.1	0.19
	Min	5.0	42.9	20.3	16.2		39.1	26.6	12.0	16.3		29.6	5.9	10.0	27.9	8.3	10.7	17.0	8.1	4.50
	Max	6.9	53.7	25.9	18.5		44.1	30.4	13.2	21.9		34.8	6.7	13.2	33.4	9.4	12.7	18.6	8.6	5.04
	n=	6	6	6	6		6	5	5	5		5	5	5	5	5	5	6	6	5
♀♀	X	7.4	44.9	24.3	16.5		41.5	28.4	12.9	19.9		31.3	6.5	12.6	30.4	9.0	12.1	17.4	8.3	4.37
	± SD	1.2	2.6	2.0	0.9		1.0	1.0	0.5	1.5		1.2	0.4	0.7	1.3	0.6	0.6	0.6	0.6	0.28
	Min	5.5	41.2	21.1	14.9		40.0	26.7	11.9	16.9		29.4	5.8	10.5	28.4	7.3	11.0	16.4	7.3	3.93
	Max	9.5	54.1	30.2	18.0		43.4	31.1	14.0	22.8		34.0	7.4	14.1	33.0	10.1	13.4	18.4	10.3	4.96
	n=	22	22	22	22		22	22	22	22		22	22	22	22	22	22	22	22	21

Table 7. Measurements of Rhinolophidae from Burkina Faso.



captured from a cave where we placed nets at the entrance. Several other species were also present, including *Hipposideros abae*, *H. ruber*, *H. tephros* and *Nycteris macrotis*. All specimens that we captured were orange-yellow; which makes it easier to distinguish it from *R. alcyone* and *R. fumigatus*. One male was calling at 108.5 kHz. It had a horse-shoe width of 7.0 mm and well-developed reddish-brown axillary tufts. A female called at 105.6 kHz with a horseshoe 7.3 mm wide.

Family RHINOPOMATIDAE  
Genus *Rhinopoma* E. Geoffroy, 1818  
*Rhinopoma cytops* Thomas, 1903

Hulva et al. (2007) restrict *R. hardwickii* to Asia and *R. cystops* to Africa and Western Asia. *Rhinopoma cytops*, found in the Northern Sahara (Horáček et al., 2000) is a species from desert to semi-desert areas (Hill, 1977; Van Cakenberghe &

De Vree, 1994). In Burkina Faso, it has been found in the northern Sahelian as well as in the South-Sudanian zone, suggesting a rather loose association with climatic areas in the country (Fig. 6). In the South-Sudanian area, its presence seems to be linked to the presence of rocky formations and rugged topography.

Averages of body measurements (except HB, 3Ph1, 3Ph2, 4Ph2 and 5Ph2) of males are smaller than those of females. On the other hand, averages of cranial measurements of males are higher than those of females (Table 8). The tail being actually longer than the forearm, one can distinguish it from *R. microphyllum*.

*Rhinopoma microphyllum* (Brünnich, 1782)

*Rhinopoma microphyllum* seem to occur in similar habitats as *R. cystops* (Qumsiyeh, 1985). In Burkina Faso, *R. microphyllum* has been recorded from the North-Sahelian zone (Fig. 6). Although this

Rhinopoma cystops																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	9.8	62.0	69.0	19.2	7.5	57.1	39.0	9.5	14.8		33.7	12.5	10.1	39.1	10.1	8.8	25.5	12.6	4.23	7.78	6.01
	Min	8.5	54.0	64.5	18.3	6.8	54.9	37.6	8.5	12.1		31.8	11.8	9.1	37.0	9.1	7.5	23.0	11.2	4.14	7.66	5.97
	Max	10.5	68.1	71.8	20.7	8.3	58.4	40.9	10.2	16.0		35.6	12.8	11.2	40.6	10.5	9.6	27.3	13.5	4.31	7.91	6.07
	n=	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4	4
♀♀	X	11.5	60.5	71.0	19.6	7.2	59.4	41.5	8.7	14.3		34.6	12.6	9.7	40.7	10.8	8.4	27.0	13.0	4.21	7.66	5.86
	Min	9.5	58.1	68.8	18.1	6.8	57.2	38.6	7.7	13.7		32.5	11.5	9.0	38.5	9.5	8.0	24.7	12.6	4.09	7.49	5.79
	Max	14.0	62.1	74.5	20.5	7.8	60.6	43.5	9.3	15.1		36.1	13.2	10.5	42.0	12.1	8.9	28.3	13.2	4.28	7.79	5.96
	n=	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	3	3

Table 8. Measurements of Rhinopomatidae from Burkina Faso.

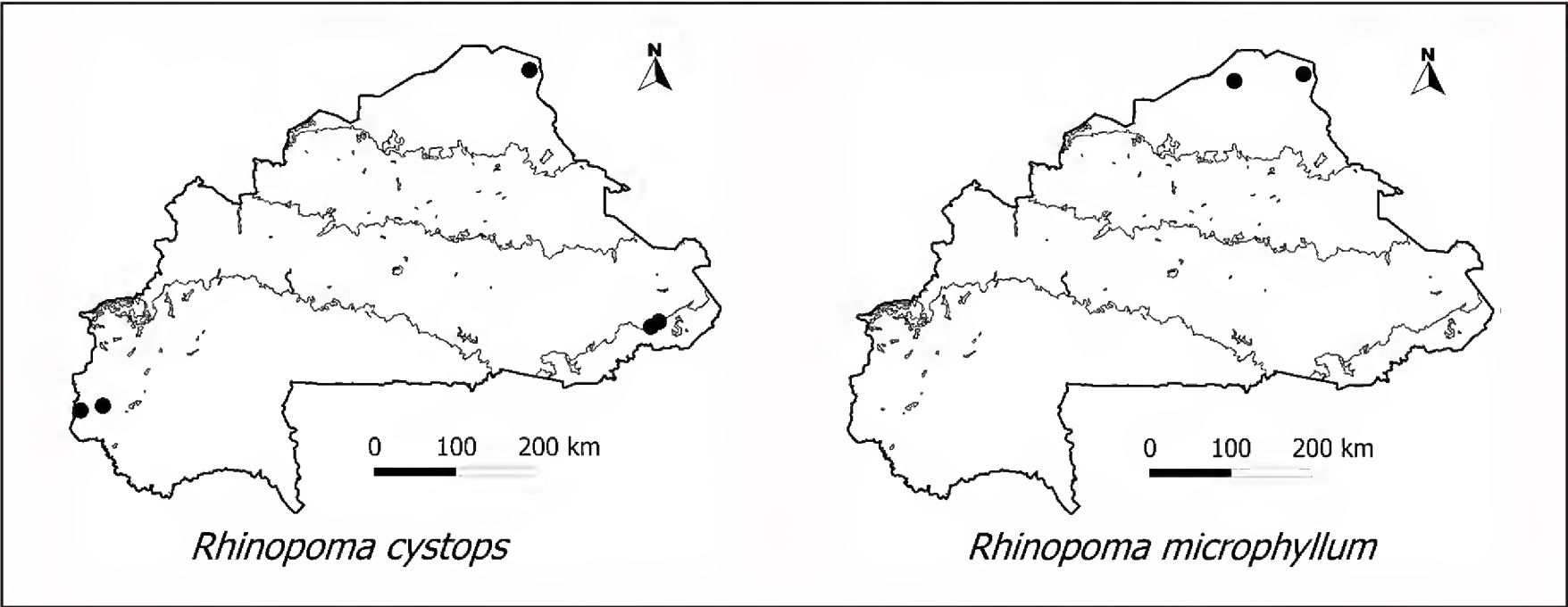


Figure 6. Distribution of Rhinopomatidae in Burkina Faso.

species has often been encountered in the same day roosts as *R. cystops* (though usually in smaller numbers) (Schlitter & Qumsiyeh, 1996), no specimen was recorded in the Sudanian zone of Burkina Faso.

#### Family EMBALLONURIDAE

Genus *Coleura* Peters, 1867

*Coleura afra* (Peters, 1852)

Rarely seen in West Africa, *Coleura afra* is located in the southwest in the South-Sudanian zone (Fig. 7). This cave-dwelling species has been captured only in this part of the country. Thousands of individuals have indeed been observed in this cave located on a hill at Néguéni. It is the smallest of Emballonuridae present in Burkina Faso (Table 9).

As observed by Goodman et al. (2008), males differ from females. Indeed, averages of body measurements and cranial measurements of the females are larger than those of males. In addition, maximum cranial measurements (M3-M3 and C-M3) of males are smaller than the minimum cranial measurements of females (Table 9).

Genus *Taphozous* E. Geoffroy, 1818

*Taphozous nudiventris* Cretzschmar, 1830

Also known in the North of Sahara (Horáček et al., 2000), *Taphozous nudiventris* is particularly located in the North-Sahelian zone (Fig. 7). However, this species widely distributed in the dry areas of African savannas (Koopman, 1975) has just been located in the extreme southwest in the South-Sudanian zone. Its presence could be explained by the nature of the area in which these specimens have been captured. Indeed, the peaks of Sindou represent specific formations with very little vegetation and water with a lot of cracks that can lodge this species. As indicated by Benda et al. (2006), this species is often captured in its lodgings, in narrow shelters and in cracks. Actually in the peaks of Sindou, *T. nudiventris* has been captured at the top of the peaks, in cracks of rocks serving as shelters.

Body measurements (except 4Ph2 and 5Ph2) and all cranial measurements show that *T. nudiventris* is larger than *T. perforatus* (Table 9).

*Taphozous perforatus* E. Geoffroy, 1818

Found in the northern Sahara (Horáček et al.,

2000), *Taphozous perforatus* is widely distributed in the Sahelian zone (Fig. 7). Also present in the W park bordering Niger (Poché, 1975), it was not surprising to encounter it in this part of Burkina Faso. Indeed, *T. perforatus* has just been located in the extreme South-East in the South-Sudanian zone.

But unlike the specimens captured by Poché (1975) in the hollow of a baobab, specimens captured in Burkina Faso during the BIOTA collect come from a cave. These have been captured on the Gobnangou range in the presence of a colony of

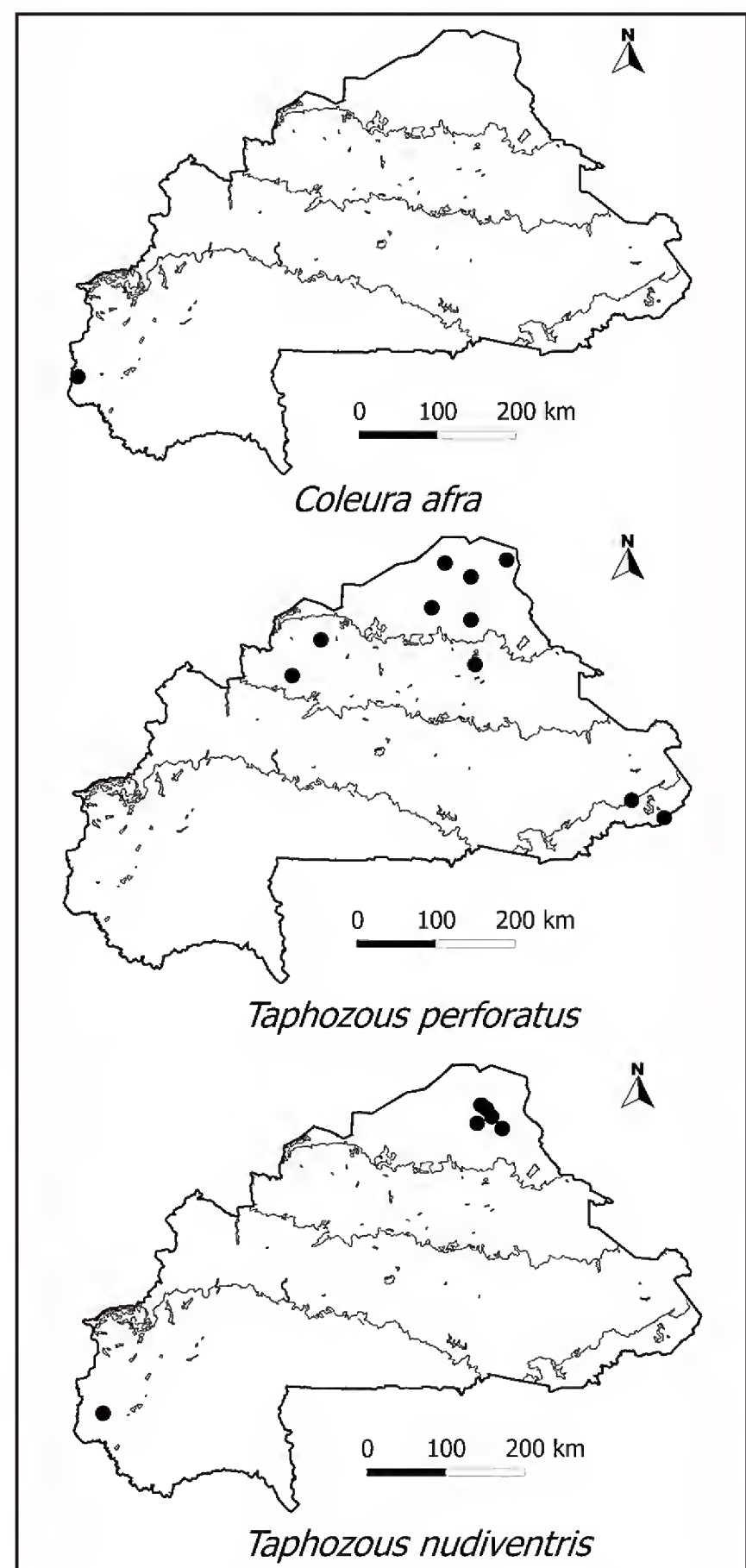


Figure 7. Distribution of Emballonuridae in Burkina Faso.



Coleura afro																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	9.8	64.0	17.8	15.3	6.0	51.1	44.9	16.3	17.2	36.8	12.6	6.5	32.6	13.2	5.8	18.2	10.2	4.13	7.83	7.02
	Min	9.5	63.2	16.3	15.2	5.5	49.9	43.1	15.1	16.7	35.3	12.2	5.9	32.3	12.8	5.4	18.1	10.1	4.10	7.77	6.96
	Max	10.5	64.4	20.3	15.5	6.8	52.1	45.9	17.2	18.1	37.8	12.9	7.4	33.0	13.9	6.1	18.4	10.3	4.17	7.88	7.12
	n=	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
♀♀	X	11.2	66.4	17.9	15.8	6.3	52.7	48.2	17.7	17.4	38.8	13.2	7.1	33.8	14.0	5.9	19.0	10.6	4.25	8.17	7.33
	Min	10.5	65.8	16.9	15.5	6.2	51.1	46.4	17.6	16.4	37.3	12.9	6.7	33.0	13.9	5.4	18.2	10.2	4.14	8.16	7.24
	Max	11.5	67.3	20.0	16.3	6.5	54.0	49.9	17.8	18.3	39.7	13.4	7.4	34.8	14.1	6.6	20.2	10.8	4.32	8.18	7.39
	n=	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Taphozous nudiventris																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂	60.0	105.3	38.9	20.8	6.1	80.5	74.6	31.7	30.5		60.8	16.8	9.6	52.3	16.6	9.8	32.3	16.2	6.22	11.22	11.51
♂	61.5	108.2	37.2	21.0	6.7	73.4	67.7	28.5	30.2		55.4	16.6	8.9	47.2	16.0	9.2	31.2	17.9	6.63	11.07	11.08
♀	53.0	102.9	40.3	19.9	6.2	75.9	70.6	29.9	31.8		56.1	16.2	6.8	46.9	16.3	9.2	32.3	14.7	5.69	10.55	11.34
Taphozous perforatus																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂	20.3	70.1	26.7	18.8	5.0	63.7	56.9	20.5	21.5		46.6	12.8	9.6	38.0	13.9	9.2	25.9	12.2	3.89	8.17	8.42
♂	18.0	73.5	25.5	19.2	6.1	62.5	56.4	19.9	21.6		46.0	13.1	9.0	37.2	13.5	8.5	24.5	13.0	3.76	8.48	8.42
♀ (YAD)	16.3	67.0	27.7	16.8	5.0	61.4	55.1	18.5	19.8		44.5	11.6	8.3	36.0	13.5	8.2	23.9	12.1	3.71	8.15	8.38
♀	19.5	72.1	25.5	18.0	5.5	63.4	57.1	20.0	21.5		46.3	12.5	9.1	37.2	13.9	9.6	24.3	12.8	3.76	8.29	8.34

Table 9. Measurements of Emballonuridae from Burkina Faso.

about a hundred specimens. Others have been captured just at a cave entrance in an old attic in the presence of some *Rhinopoma cystops*. Like *R. cystops*, the presence of *T. perforatus* in this part of Burkina Faso seems to be linked to the presence of caves. It would therefore not be surprising to find specimens in the caves of the Southwest.

Family NYCTERIDAE

As pointed by Van Cankenberghé & De Vree (1998), *Nycteris thebaica* and *N. gambiensis* are species difficult to distinguish. Indeed, the measurements do not allow us to separate the few specimens collected during 2002 to 2009. They have been captured in a shrubby savanna next to a mountain assembly line, in a gallery forest along a river, in a gallery forest close to a depression, in a house and in the palaces of Senoufo kings.

Genus *Nycteris* Cuvier et E. Geoffroy, 1795  
*Nycteris gambiensis* (K. Andersen, 1912)

*Nycteris gambiensis* is mainly found in savannas of West Africa (Van Cakenberghé & De Vree, 1998). In Burkina Faso, it is particularly located in the western Sudanian zone with a few areas in the east (Fig. 8).

*Nycteris grandis* Peters, 1865

*Nycteris grandis* is located in the extreme Southwest in the South-Sudanian zone (Fig. 8). In Burkina Faso, it is easily distinguished from other Nycteridae by its large size (Table 10). Unlike Adam & Hubert (1976), who stated that it cannot be found outside the Guinean zone; or Van Cakenberghé & De Vree (1993) who said that *N. grandis* is restricted to rainforests, its presence in the protected forest of Lera in a gallery forest, confirms the statement of Rosevear (1965) according to which *N. grandis* can also be present outside the rainforest, in dense and moist gallery forest. Also, in Southern and Central Africa, this species is well known to occur outside of the rainforest zone (Monadjem et al., 2010).

*Nycteris hispida* (Schreber, 1774)

Present in the woody Guinean and Sudanian areas, *Nycteris hispida* is widely distributed in the West of the Sudanian zone with a few specimens in the East (Fig. 8). Although Rosevear (1965) thinks that it could spread further into the Sahelian areas, no specimen was captured in this part of Burkina Faso. All specimens captured in BIOTA project were brown. Some females captured during the month of September were carrying their young.

*Nycteris macrotis* Dobson, 1876

Known in the forests and savannas of West Africa (Adam & Hubert, 1976; Van Cakenberghe & De Vree, 1985), *Nycteris macrotis* is located in all phytogeographic zones in Burkina Faso (Fig. 8). The diversity of its habitats composed of hollow logs, hollowed termitarium, wells and even simple holes in the ground (Adam & Hubert, 1976), en-

ables this species to be found in all parts of Burkina Faso. However, it is more present in the South-Sudanian zone with a reduction of its presence in the North. Five specimens were captured in the protected forest of Niangoloko at the entrance to a cave with other species such as *Hipposideros abae*, *H. tephros*, *H. ruber* and *Rhinolophus landeri*. All specimens collected during our study had two colors. Some were brown and other orange-yellow.

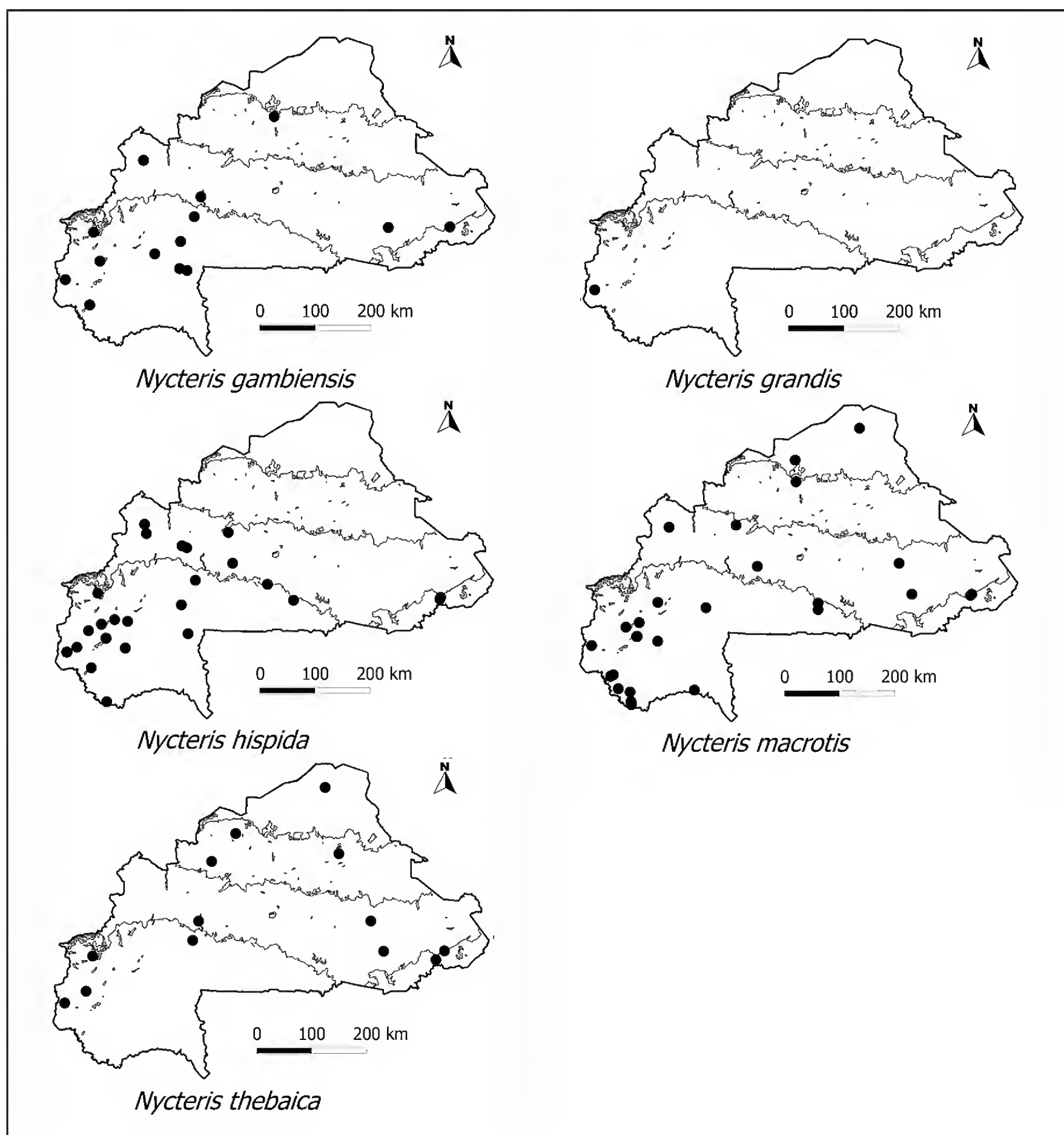


Figure 8. Distribution of Nycteridae in Burkina Faso.



Nycteris grandis																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂	22.0	69.1	66.9	30.1	6.4	55.5	44.0	28.1	29.2	5.2	47.7	16.4	13.0	50.7	15.9	14.8	29.0	12.5	6.93	10.16	9.32	
♀	24.0	69.8	63.5	30.4	6.3	57.4	44.3	28.8	29.9	5.5	49.0	16.1	13.9	52.0	16.4	14.5	30.5	13.4	6.65	10.33	9.06	
Nycteris hispida																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂♂	X	6.3	45.1	45.5	21.0	4.8	38.9	31.9	21.9	21.1	3.1	33.9	12.2	7.7	34.0	12.1	9.4	19.4	8.5	4.24	6.49	5.83
	± SD	0.4	0.9	0.9	0.8	0.3	1.0	0.6	0.7	0.7	0.7	0.5	0.5	0.7	0.7	0.3	0.2	0.8	0.7	0.20	0.13	0.15
	Min	5.8	43.5	43.9	19.7	4.3	37.6	30.8	20.9	20.1	1.7	32.8	11.3	6.4	33.2	11.6	9.1	18.2	7.4	4.03	6.31	5.54
	Max	7.0	46.1	46.7	22.3	5.1	40.9	32.5	23.0	22.1	4.1	34.5	12.9	8.5	34.9	12.7	9.7	20.8	9.5	4.55	6.76	5.96
	n=	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
♀	6.5	45.5	52.1	23.4	5.1	39.2	33.0	22.7	22.8	3.2	36.0	13.4	9.3	35.1	13.5	9.9	18.8	9.0	4.53	6.81	5.85	
Nycteris macrotis																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂♂	X	12.5	55.6	55.0	30.7	8.0	47.9	37.7	24.8	24.3	4.7	41.2	13.8	11.7	43.3	13.4	12.7	23.6	11.4	5.77	8.29	7.46
	± SD	1.2	1.2	2.7	1.7	0.3	2.2	1.4	1.2	1.0	0.8	1.5	0.8	0.9	2.7	0.7	1.1	0.9	0.9	0.18	0.26	0.24
	Min	11.0	54.0	50.3	28.6	7.5	44.1	36.1	22.8	22.5	4.0	39.5	12.6	9.9	39.1	12.0	10.4	21.9	9.8	5.45	7.87	7.15
	Max	14.5	57.4	58.8	33.4	8.6	51.4	40.5	26.3	26.0	6.0	44.6	15.2	13.0	48.3	14.4	14.2	24.6	12.6	6.00	8.72	7.81
	n=	8	8	8	8	8	8	8	8	8	7	8	8	8	8	8	8	8	8	8	8	8
♀♀	X	14.5	58.6	57.3	31.9	7.9	48.6	38.9	26.1	25.4	4.5	43.2	14.5	11.7	44.5	14.0	12.7	24.4	11.5	5.68	8.43	7.51
	± SD	1.9	2.7	3.7	1.8	0.5	1.6	1.2	0.6	1.6	0.9	1.0	0.6	0.7	1.3	0.5	0.8	0.7	0.8	0.19	0.25	0.16
	Min	12.0	55.6	51.5	29.0	6.9	46.3	36.6	24.6	23.1	2.5	41.6	13.5	10.6	42.2	13.0	11.2	23.2	10.3	5.27	7.94	7.26
	Max	18.0	64.7	63.9	35.2	8.6	51.4	41.2	27.3	28.5	5.8	44.5	15.5	12.5	46.7	14.8	14.0	25.3	12.8	6.12	8.96	7.85
	n=	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	12	13
Nycteris thebaica and N. gambiensis																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂♂	X	7.0	47.1	50.0	26.8	7.5	41.1	32.6	22.5	21.2	3.8	35.2	12.6	9.3	35.5	12.5	10.4	22.2	9.2	4.18	6.58	6.22
	± SD	0.8	0.8	3.0	1.1	0.3	1.6	1.2	0.7	1.1	0.4	1.2	0.9	0.5	1.3	0.8	0.4	0.8	0.5	0.10	0.20	0.14
	Min	6.5	46.1	45.8	25.1	7.0	38.9	30.3	21.2	19.4	3.3	32.9	11.6	8.6	33.4	11.4	9.9	21.0	8.4	4.06	6.35	6.06
	Max	8.5	48.4	53.4	28.1	7.7	43.5	33.5	23.3	22.8	4.4	36.1	13.8	9.9	36.9	13.7	11.2	23.4	9.8	4.34	6.92	6.45
	n=	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
♀	10.0	50.2	52.6	30.8	7.7	43.8	36.5	25.1	26.2		38.0	13.4	11.1	39.3	13.9	12.4	22.7	9.9	4.74	7.22	6.71	
♀	8.0	48.3	52.5	30.1	7.1	43.0	32.2	22.4			35.6	12.9	9.1	36.6	12.6	11.1	22.6	9.2	4.41	6.87	6.44	

Table 10. Measurements of Nycteridae from Burkina Faso.

Nycteris thebaica E. Geoffroy, 1818

Found in all phytogeographic zones, even the desert and the Arabian Peninsula except rainforests and central Sahara (Van Cakenberghe & De Vree, 1993), *Nycteris thebaica* is present in all phytogeographic areas in Burkina Faso (Fig. 8). Indeed, this anthropic species lives in habitats such as millet granaries as well as in trees (Adam & Hubert, 1976). However, it seems less present in the South-Sudanian zone than the rest of the country.

Family MOLOSSIDAE

Genus *Chaerephon* Dobson, 1874

*Chaerephon major* (Trouessart, 1897)

Even if they captured it in only two areas,

Koopman et al. (1978) had already suggested that *Chaerephon major* was probably widespread in Burkina Faso (Fig. 9). Indeed, as a typical African savanna species (Koopman, 1975; McLellan, 1986), *C. major* is present in all phytogeographic areas of Burkina Faso except in the South-Sahelian zone. Lodged in crevices, cracks or in aggregates of rocks in rivers, hollow trees and holes in houses (Rosevear, 1965), it would therefore not be surprising to find it in the South-Sahelian zone. All three new specimens have been captured in the protected forest of Niouma in a shrubby savanna and in an open forest. *Chaerephon major* is smaller than *C. nigeriae*. The maximum values of body measurements (Bm, HB, FA, 3Met, 4Met, 5met, 5Ph1 and 5Ph2) and cranial measurements of *C. major* are lower than the body measurements and cranial measurements of *C. nigeriae* (Table 11).

***Chaerephon nigeriae* Thomas, 1913**

*Chaerephon nigeriae* is located in Southcentral and extreme Southwestern part in Sudanian zone (Fig. 9). The five specimens have been captured in a gallery forest along a stream at Galgouli and in an open forest and shrubby savanna in the protected forest of Niouma. It is the largest *Chaerephon* found in Burkina Faso.

The measurement of the forearm helps to separate it from others present in Burkina Faso (Table 11).

***Chaerephon pumilus* (Cretzschmar, 1830)**

*Chaerephon pumilus* is the most easily found species in Burkina Faso among Molossidae. It is the smallest *Chaerephon* in Burkina Faso. It is therefore recognizable by its size. Present in a variety of habitats, in semi-arid areas in the North to the forest areas of the South (Happold, 1987), *C. pumilus* is present in all phytogeographic areas in Burkina Faso, even though it is mainly located in the Sudanian zone (Fig. 9). Only a few specimens are known from the Sahelian zones. Very often found in roofs of houses, *C. pumilus* finds in southern Burkina Faso, a variable and high number of habitats, able to serve as its lodging places.

Genus *Mops* Lesson, 1842

***Mops condylurus* (A. Smith, 1833)**

Found in the Sahelian areas and even in rainforests, *Mops condylurus* has no preference for any particular habitat (Rosevear, 1965). In Burkina Faso, it is located in the Sudanian zone (Fig. 9). The specimens have been captured in a shrubby savanna on the edge of a forest, in a shrubby savanna near a mountain assembly line, and next to a pond.

Measurements of body and cranial measurements do not help in distinguishing males from females (Table 11).

***Mops demonstrator* (Thomas, 1903)**

Rarely seen in West Africa, it is the second time that *Mops demonstrator* is reported in Burkina Faso. The four specimens examined by Koopman et al. (1978), have been captured near the river Nazinon. The specimen examined during the BIOTA collect has also been captured along a stream in a

grassy steppe. All specimens have been located in the extreme South in the South-Sudanian zone (Fig. 9). It is easily comparable to *M. condylurus*.

Cranial measurements do not allow to distinguish them, but the body measurements (Tail, FA, 3Met, 3Ph1, 3Ph2, 4Met, 4Ph1, 4Ph2, 5Met, Tib and HF) of *M. demonstrator* are smaller than those of *M. condylurus* (Table 11).

***Mops midas* (Sundevall, 1843)**

*Mops midas* is a species of African savannas (Koopman, 1975) and particularly isolated in the forests of savannas (Peterson, 1972). Like all other *Mops* found in Burkina Faso, it is located in the Sudanian zone (Fig. 9). Only two specimens are reported from Burkina Faso. These specimens, examined by Koopman et al. (1978), have been captured near the river Nazinon, almost the same environment from where they reported *M. demonstrator*. This is the only area of presence of this species known to date in Burkina Faso, as no other specimen of *M. midas* has yet been captured.

It is the largest of *Mops* found in Burkina Faso. Aside from the measurement of tragus of *M. midas* which is below the minimum values of *M. condylurus* and those of *M. demonstrator*, all other measurements of *M. midas* are superior to the maximum values of *M. condylurus* and the measurements of *M. demonstrator* (Table 11).

**Family VESPERTILIONIDAE**

Genus *Glauconycteris* Dobson, 1875

***Glauconycteris variegata* (Tomes, 1861)**

*Glauconycteris variegata* is located in West Central area in the North-Sudanian zone (Fig. 10). As noted by Rosevear (1965) this is a species that inhabits open areas rather than rainforests.

Genus *Myotis* Kaup, 1829

***Myotis bocagii* (Peters, 1870)**

*Myotis bocagii* has been found in the southwest and southeast of the Sudanian zone (Fig. 10). It is a forest species also found in the gallery forests along rivers, in savanna areas (Green, 1983). All specimens captured during BIOTA collect are from the cliffs of Banfora. This is the second area where the species is identified.



Genus *Neoromicia* Roberts, 1926

*Neoromicia capensis* (A. Smith, 1829)

*Neoromicia capensis* is located at the extreme southwestern area in South-Sudanian zone (Fig. 10). The specimen has been captured in a gallery forest along a stream between hills.

Measurements of body and cranial measurements of *N. capensis* exceed the maximum meas-

urements (except Bm, 3Ph3, HF of males and except Bm, 3Ph3, HF, CC, and CM of females) of *N. somalica*. They are also higher than the maximum values (except 3Ph2, 3Ph3, Tib, HF of males and except HB, Tail, 3Ph3, 4Ph1 and HF of females) of *N. guineensis* (see Table 13 and 14). Body measurements do not really allow distinguishing them. However, measurement of the forearm of *N. capensis* is larger than that of *N. somalica* and *N. guineensis* (Table 12).

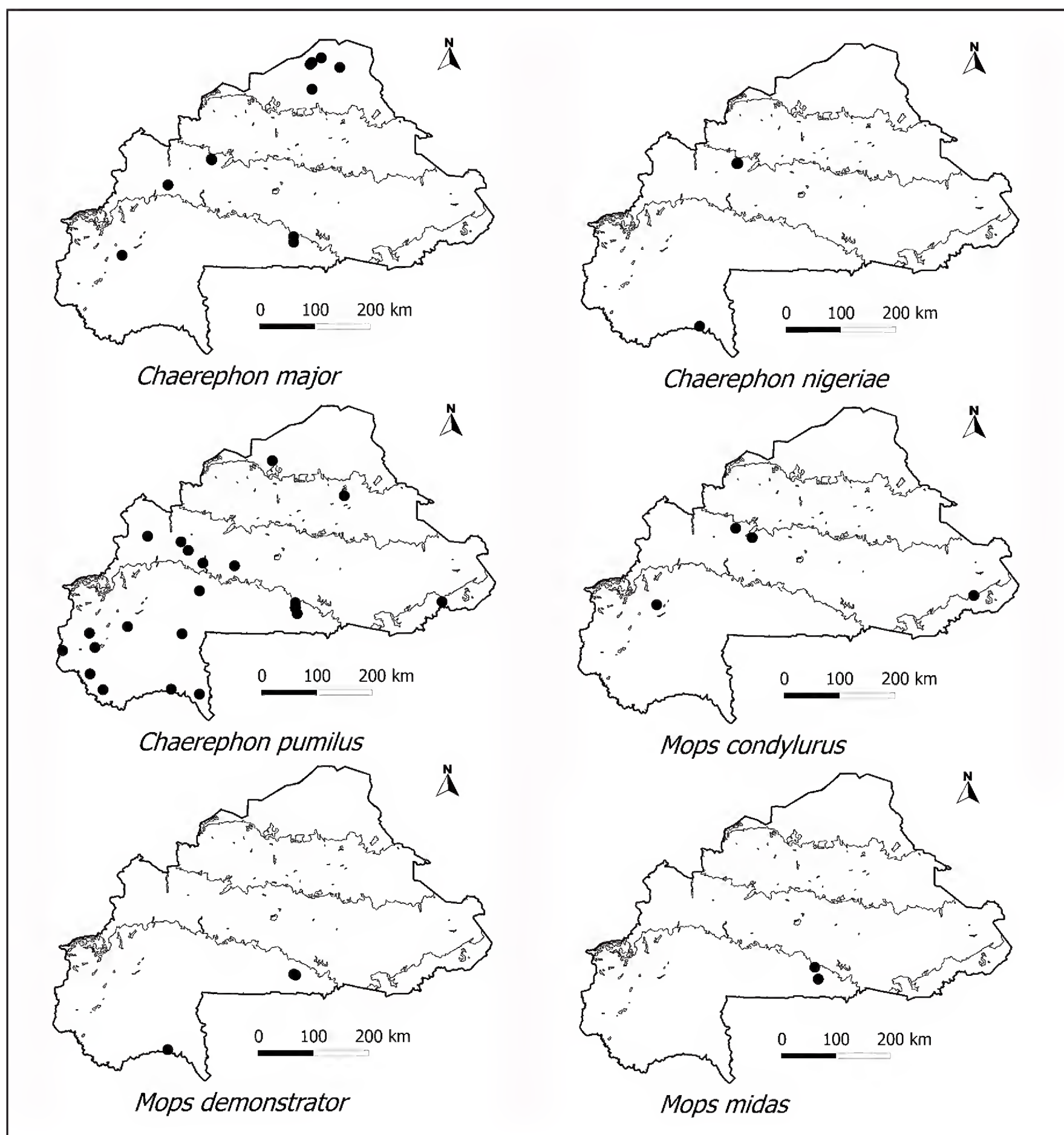


Figure 9. Distribution of Molossidae in Burkina Faso.

Chaerephon major																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	15.1	66.7	34.3	17.1	3.5	43.0	44.0	19.0	17.7	8.3	42.2	15.6	12.2	27.4	13.4	5.1	13.4	8.3	4.97	8.20	7.01
	± SD	0.2	0.3	2.6	0.7	0.1	0.8	1.3	0.9	0.6	1.2	1.2	0.5	0.7	1.0	0.3	0.5	0.7	0.6	0.08	0.07	0.17
	Min	14.8	66.2	31.1	16.0	3.4	42.0	42.2	18.0	16.7	7.1	41.0	14.9	11.2	25.9	13.0	4.6	12.3	7.6	4.84	8.14	6.74
	Max	15.3	66.9	36.9	17.8	3.7	44.2	45.8	20.1	18.5	10.0	43.9	16.1	13.0	28.4	13.9	5.5	14.3	9.4	5.06	8.31	7.21
	n=	3	4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	5	5	4	4	4
♀ (USNM 452890)		40.4																12.0	8.2	5.07	7.82	6.65
Chaerephon nigeriae																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂		18.5	73.0	41.4	21.3	3.0	48.7	50.0	20.4	20.9	8.5	47.9	16.4	13.2	30.7	15.0	6.5	15.0	9.1	5.43	8.96	7.60
♂		20.3	74.8	40.1	21.6	3.0	49.6	49.9	21.1	20.5	9.5	47.5	16.9	12.7	30.2	15.7	5.8	15.9	8.8	5.90	8.83	7.64
♀		18.8	72.2	34.9	17.5	3.4	47.7	48.0	19.4	18.4	8.7	47.5	15.3	12.4	30.1	14.6	5.6	14.7	8.5	5.33	8.79	7.43
Chaerephon pumilus																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂	X	8.6	53.3	30.7	15.5	3.2	36.1	36.4	15.1	14.9	6.5	35.4	12.6	10.3	23.3	11.1	4.0	11.7	6.7	4.19	7.20	5.90
	± SD	0.8	1.7	1.5	1.0	0.3	0.8	1.4	0.7	0.5	0.7	1.1	0.5	0.6	0.9	0.8	0.3	0.6	0.5	0.20	0.16	0.12
	Min	7.5	50.7	27.3	14.2	2.8	34.1	34.5	14.1	13.8	5.2	33.7	11.7	9.3	21.7	10.0	3.4	10.6	5.7	3.82	6.94	5.63
	Max	10.0	57.0	33.4	17.6	3.7	37.5	38.7	16.2	15.6	7.4	37.3	13.4	11.2	24.8	12.4	4.4	12.7	7.8	4.47	7.49	6.10
	n=	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
♀♀	X	8.6	53.0	31.4	15.5	3.4	36.4	36.3	15.3	15.1	6.2	34.8	12.5	10.6	22.8	11.1	4.1	11.9	6.5	3.92	6.90	5.79
	± SD	0.9	1.9	2.0	0.7	0.4	0.6	1.2	0.6	0.7	0.5	1.1	0.6	0.7	0.8	0.7	0.2	0.8	0.5	0.08	0.21	0.11
	Min	7.0	50.7	28.5	13.8	2.9	35.5	34.7	14.0	14.0	5.4	33.3	11.5	9.3	21.4	9.7	3.7	10.3	6.0	3.78	6.53	5.58
	Max	10.0	57.7	34.7	16.6	4.3	37.6	38.4	16.3	16.4	7.1	37.1	13.4	11.6	24.2	12.4	4.5	12.9	7.7	4.06	7.18	6.09
	n=	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
Mops condylurus																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂ (SAD)		23.0	69.2	36.0	18.4	3.4	48.5	51.1	22.9	21.1	9.3	48.9	18.0	14.6	34.1	14.0	5.3	16.8	11.0	5.74	9.38	7.51
♂		23.8	69.8	39.4	18.9	2.8	48.2	48.8	23.4	22.2	10.3	47.5	18.9	15.8	34.0	14.6	5.5	17.2	11.0	5.68	8.78	7.15
♀♀	X	24.8	67.6	39.6	18.1	3.0	46.6	48.3	22.6	22.0	9.4	47.0	18.1	15.7	32.8	13.5	5.5	16.6	10.8	5.34	8.82	7.35
	Min	23.5	66.6	37.5	17.5	2.8	45.3	47.5	21.7	21.9	8.2	46.3	17.2	15.2	32.0	13.4	5.2	16.2	10.6	5.15	8.74	7.14
	Max	26.0	69.4	42.5	18.6	3.2	48.4	50.2	23.3	22.2	10.6	48.4	18.6	16.3	33.6	13.7	5.8	17.1	11.2	5.55	9.05	7.53
	n=	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Mops demonstrator																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♀		25.8	71.8	34.1	17.7	3.8	43.4	44.1	18.6	17.5	7.6	42.6	14.4	12.0	26.0	13.5	5.8	15.0	8.8	5.55	9.18	7.53
Mops midas																						
Sex		BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>3</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♀ AD (USNM 503956)		100	47	28	2	63.3												18.9	13.6	8.30	11.84	10.44

Table 11. Measurements of Molossidae from Burkina Faso.

Neoromicia guineensis (Bocage, 1889)

*Neoromicia guineensis* is present in almost all phytogeographic areas of Burkina Faso. It is widely distributed in the Sudanian zone with a few specimens in the North-Sahelian zone (Fig.10). It is easily comparable to *N. somalica*. Although the weight (WB) of *N. guineensis* is greater than the weight of *N. somalica*, averages of body measurements (except Tail 3Ph1, 3Ph2, 3Ph3, 5Ph1, 5Ph2) of males from *N. somalica* are higher than those of males from *N. guineensis* and averages of body measurements (except Tail, 3Ph1, 3Ph2, 4Ph1, 4Ph2, 5Ph1, 5Ph2 and Tib) of females from *N. somalica* are higher than those of females from *N. guineensis*.

The body measurements of males (except Bm and HB) from *N. somalica* and *N. guineensis* overlap, as well as those of females. Body measurements do not allow to distinguish them. However, the minimum cranial measurements of *N. somalica* are higher than the maximum cranial measurements of *N. guineensis* (Table 12). Only cranial measurements thus enable separating them. Averages of body measurements (except Ear, 3Ph2) and cranial measurements of females are higher than those of males.

Neoromicia nana (Peters, 1852)

*Neoromicia nana* is located in the South-Su-



danian zone (Fig.10). The specimens have been captured in a gallery forest along a water stream, in the cliffs of Banfora, in a woody savanna along a rupicolous bar, next to a dam and along a stream at the end of the hills.

***Neoromicia rendalli*** (Thomas, 1889)

It is located in the South-East in the South-Sudanian zone (Fig. 10). It seems to be essentially present in dry areas of Guinean, Sudanian and Sahelian open forests (Rosevear, 1965). The specimen has been captured in a woody savanna near a managed water point. It seems to be essentially present in dry areas of Guinea, Sudanian and Sahelian open forests (Rosevear, 1965). *Neoromicia rendalli* is easily distinguishable from other *Neoromicia* by the white color of its wings and its forearm which is longer than that of others present in Burkina Faso (Table 12).

***Neoromicia somalica*** (Thomas, 1901)

*Neoromicia somalica* is less distributed than *N. guineensis*. This species is particularly located in the South-Sudanian zone (Fig. 10).

The averages of body measurements (except Tra, 3Ph1, 4Ph1, 4Ph2, 5Ph2 and HF) and cranial measurements (except CM) of females are larger than those of males. These are mainly measurements of the forearm and cranial measurements, especially those of the upper incisors show a slight difference between males which are slightly smaller than females (Table 12).

Genus *Nycticeinops* Hill et Harrison, 1987

***Nycticeinops schlieffenii*** (Peters, 1859)

*Nycticeinops schlieffenii* is present in almost all phytogeographic zones (Fig.10). Although no specimen has been captured in the South-Sahelian zone, this small bat inhabits open woodlands and drier areas (Rosevear, 1965). Its presence in the North-Sahelian zone shows that it will therefore not be surprising to capture it in the South-Sahelian zone.

The averages of body measurements (except Tra, 3Ph3) and cranial measurements (except CM) of females are slightly higher than those of males (Table 12).

Genus *Pipistrellus* Kaup, 1829

***Pipistrellus deserti*** Thomas, 1902

*Pipistrellus deserti* is located in the South-central zone in South-Sudanian area (Fig. 10). Only one specimen has been captured in Burkina Faso (Koopman et al., 1978). This species is rarely found in West Africa. Its presence was unexpected in Burkina Faso particularly because it is known to be a northern Sahara species (Horáček et al., 2000; Fahr et al., 2006).

***Pipistrellus inexpectatus*** Aellen, 1959

*Pipistrellus inexpectatus* is located in the southwest in the South-Sudanian zone (Fig. 10). Only two specimens have been captured in a wooded savanna along a rupicolous bar and in a gallery forest in a protected forest.

***Pipistrellus nanulus*** Thomas, 1904

Like *Pipistrellus deserti*, only one specimen of *P. nanulus* has been captured in Burkina Faso. It is located at the Centre in the North-Sudanian zone (Fig. 10).

It is more easily comparable to *P. rusticus* whose body measurements, in particular the measurements of the forearm do not help in the distinction. The best measurements to separate them remaining the cranial ones which clearly show that *P. nanulus* is smaller than *P. rusticus*. Indeed, the cranial measurements of *P. nanulus* are below the minimum measurements of *P. rusticus* (Table 12). It is the smallest *Pipistrellus* found in Burkina Faso.

***Pipistrellus rusticus*** (Tomes, 1861)

*Pipistrellus rusticus* is located in the Southwest in the South-Sudanian area and at the center in the North-Sudanian zone (Fig. 10). The specimens have been captured near a pond, in the cliffs of Banfora, along a stream at the end of the hills and in an orchard.

*Pipistrellus rusticus* is smaller than *P. inexpectatus*. Only body measurements (HB, Tail, Ear, Tra, 3Ph3 and HF) of *P. inexpectatus* are below the maximum measurements of the body of *P. rusticus*. The other body measurements in particular measurement of the forearm and wings and cranial meas-

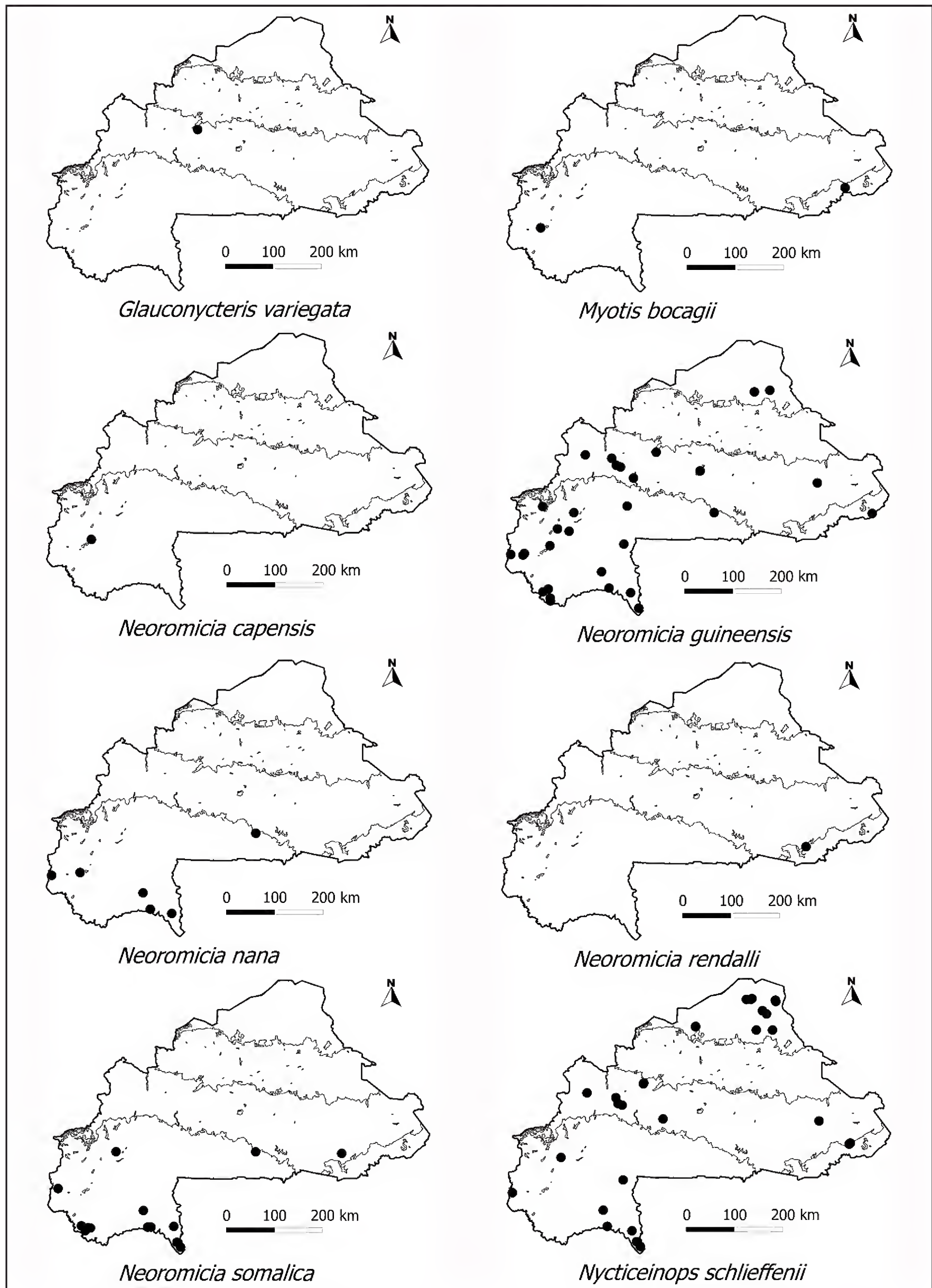


Figure 10/1. Distribution of Vespertilionidae in Burkina Faso.



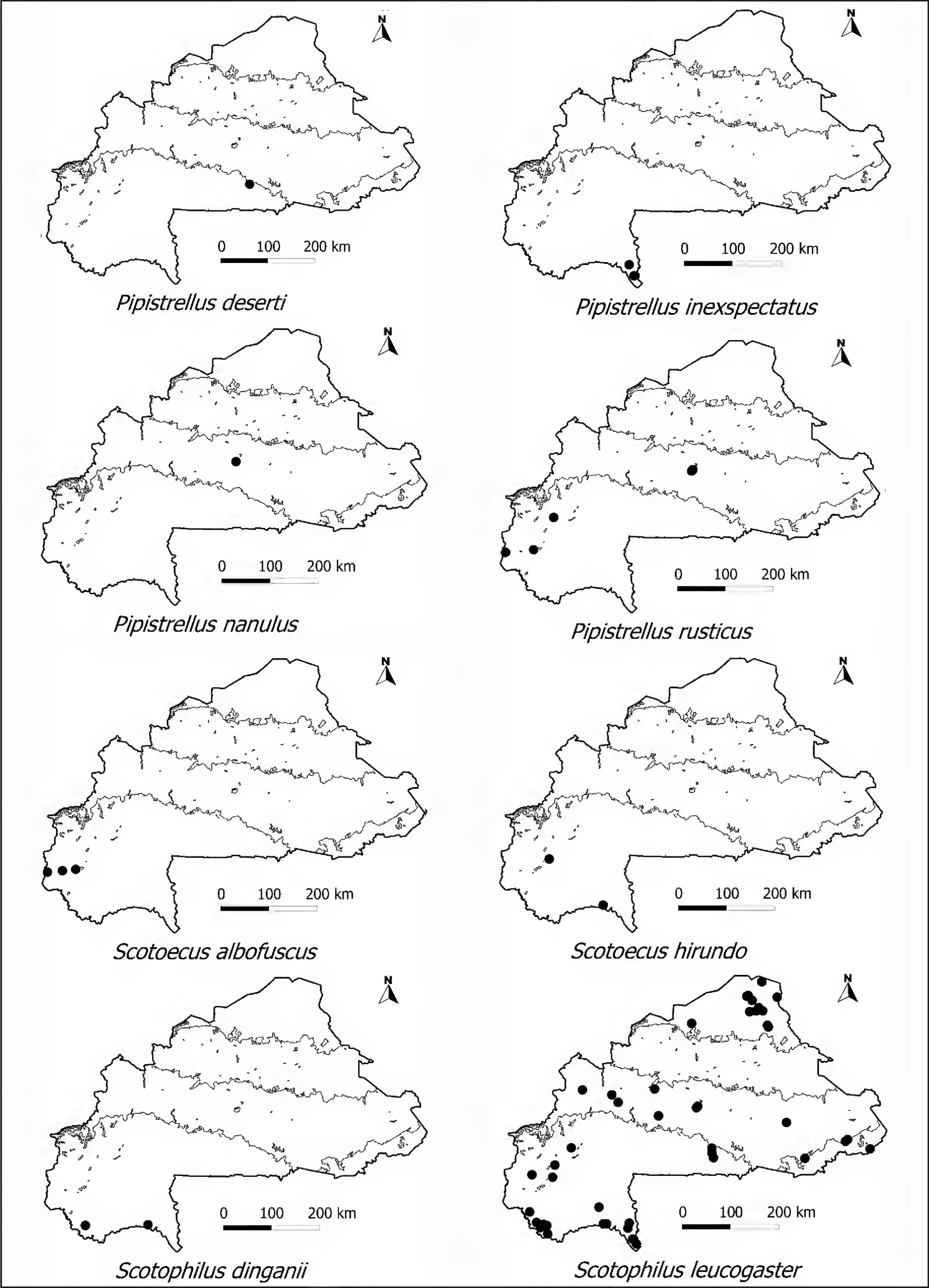


Figure 10/2. Distribution of Vespertilionidae in Burkina Faso.

Glauconycteris variegata																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♀ (SAD)	10.5	53.1	51.0	13.3	6.2	44.8	41.8	16.1	21.6	3.7	40.1	11.6	11.0	39.5	10.0	7.9	20.6	8.1	4.62	7.06	4.87	
Myotis bocagii																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂	5.5	52.5	38.4	15.1	7.5	34.7	36.6	14.2	10.9	5.8	35.1	10.2	7.6	33.9	8.8	6.3	17.2	10.6	3.83	5.77	5.61	
♀	6.5	53.1	39.2	14.2	7.2	37.7	37.0	15.7	10.8	6.1	37.6	11.6	7.7	34.4	10.1	6.7	18.6	10.9	3.98	5.87	5.78	
Neoromicia capensis																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂	4.3	50.9	33.8	15.4	6.8	32.3	31.6	12.2	10.6	6.8	30.1	10.4	10.3	30.0	10.0	7.0	12.8	6.2	4.30	5.66	4.74	
Neoromicia guineensis																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂♂	X	3.0	36.7	30.5	10.3	4.5	27.2	26.2	10.2	8.8	6.2	25.7	9.0	6.1	25.6	7.4	4.1	10.9	5.5	3.18	4.57	3.72
	± SD	0.3	1.4	1.8	0.8	0.4	1.4	1.0	0.5	0.7	0.5	1.0	0.5	0.3	1.1	0.5	0.4	0.7	0.4	0.11	0.15	0.09
	Min	2.5	34.5	25.5	8.9	4.0	25.4	24.4	9.2	7.5	5.2	24.3	8.2	5.2	23.7	6.6	3.1	9.8	4.6	2.99	4.36	3.53
	Max	3.5	39.2	35.5	12.0	5.2	31.2	27.8	11.4	10.8	7.1	27.8	10.3	6.7	27.6	8.4	5.0	13.5	6.6	3.39	4.92	3.87
	n=	24	24	24	24	24	25	24	24	24	24	24	24	24	24	24	24	25	25	25	25	25
♀♀	X	3.6	39.1	32.2	10.1	4.6	28.2	27.4	10.7	9.3	6.2	27.2	9.5	6.3	26.8	7.9	4.3	11.2	5.6	3.35	4.67	3.78
	± SD	0.3	1.7	2.0	0.4	0.3	0.7	1.2	0.4	0.5	0.6	1.3	0.6	0.5	1.2	0.5	0.4	0.6	0.5	0.14	0.14	0.10
	Min	3.0	36.0	28.5	9.4	3.9	27.0	25.2	9.9	8.3	5.2	25.5	8.5	5.4	24.3	7.0	3.5	9.8	4.4	3.13	4.47	3.61
	Max	4.3	42.1	35.6	10.9	4.9	29.6	29.4	11.5	10.0	7.2	29.3	10.4	7.1	28.5	8.5	4.9	12.0	6.3	3.61	4.95	3.95
	n=	11	12	12	12	11	14	12	11	11	11	12	11	11	12	11	11	14	14	14	14	14
Neoromicia nana																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂♀	X	3.3	38.0	29.9	9.7	3.6	27.6	26.8	8.7	7.4	4.6	26.5	7.3	5.2	26.0	6.4	3.5	10.0	5.6	3.25	4.37	3.62
	± SD	0.6	1.4	2.2	0.4	0.4	1.1	1.0	0.5	0.5	0.5	1.0	0.5	0.5	0.8	0.4	0.3	0.4	0.3	0.10	0.14	0.09
	Min	2.4	34.7	24.7	8.9	2.9	25.8	25.4	7.9	6.5	3.2	25.0	5.8	4.2	24.4	5.9	2.9	9.2	4.9	3.02	4.16	3.44
	Max	4.0	40.9	33.8	10.7	4.9	30.1	29.2	10.0	8.4	5.5	28.9	7.9	6.1	27.6	7.5	4.0	10.6	6.1	3.40	4.62	3.79
	n=	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22
Neoromicia rendalli																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♀ (SAD)	6.8	46.6	37.8	11.4	4.7	35.2	34.4	11.3	8.5	5.8	34.0	10.5	6.0	32.6	8.0	4.3	12.8	6.8	4.15	5.90	4.47	
Neoromicia somalica																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂♂	X	4.4	43.9	27.8	11.3	5.2	28.2	27.1	10.1	8.6	6.2	26.5	9.2	6.3	26.7	7.0	4.1	10.8	6.1	4.00	5.36	4.45
	± SD	0.3	1.3	1.5	0.4	0.3	0.6	0.8	0.4	0.3	0.6	0.9	0.4	0.2	0.7	0.5	0.2	0.3	0.2	0.15	0.14	0.09
	Min	4.0	42.4	25.6	10.9	4.7	27.1	25.4	9.5	8.0	5.4	24.7	8.4	6.0	25.0	6.5	3.8	10.4	5.8	3.83	5.16	4.35
	Max	4.8	46.6	29.6	11.8	5.7	29.0	28.0	10.7	9.1	7.3	27.7	9.8	6.6	27.2	7.9	4.4	11.1	6.5	4.22	5.54	4.60
	n=	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	6	6
♀♀	X	5.3	45.9	30.0	11.4	4.9	29.3	28.4	10.0	8.7	6.4	27.9	9.2	6.3	27.9	7.3	3.9	10.9	5.8	4.09	5.39	4.41
	± SD	0.8	1.7	1.4	0.4	0.4	1.0	0.9	0.4	0.5	0.5	1.0	0.6	0.3	1.0	0.4	0.2	0.4	0.4	0.12	0.14	0.08
	Min	4.3	41.2	28.1	10.9	4.3	27.3	27.2	9.4	8.2	5.5	26.6	8.3	5.8	26.5	6.7	3.5	10.3	5.2	3.96	5.16	4.25
	Max	6.5	48.7	32.6	12.0	5.4	31.1	29.6	10.7	9.9	7.2	29.5	10.1	6.9	29.3	8.1	4.3	11.6	6.3	4.37	5.67	4.54
	n=	13	13	13	12	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Nycticeinops schlieffenii																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♂♂	X	5.1	44.1	30.9	11.3	4.7	30.8	30.5	11.6	9.4	6.3	30.1	10.2	6.5	30.0	7.5	4.5	12.2	6.3	3.94	5.43	4.36
	± SD	0.4	1.8	2.5	0.5	0.3	1.1	1.3	0.7	0.7	0.8	1.0	0.6	0.5	1.1	0.5	0.3	0.5	0.4	0.14	0.15	0.12
	Min	4.5	41.9	26.4	10.4	3.9	29.3	27.8	10.6	8.4	5.1	28.8	9.1	5.7	27.7	6.7	4.1	11.4	5.5	3.73	5.17	4.18
	Max	6.0	47.2	35.4	12.1	5.1	32.5	32.6	12.9	10.9	7.7	31.8	11.1	7.4	31.7	8.6	5.2	12.9	7.3	4.15	5.61	4.60
	n=	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
♀♀	X	5.7	46.3	33.3	11.5	4.6	31.9	31.4	12.0	9.8	6.2	30.9	10.8	7.1	30.6	8.0	4.7	12.8	6.6	3.98	5.48	4.32
	± SD	0.6	1.0	1.9	0.5	0.3	1.7	1.8	0.8	0.7	0.6	1.7	0.7	0.5	1.8	0.6	0.4	0.9	0.1	0.15	0.08	0.10
	Min	5.0	43.8	30.6	10.4	4.1	29.0	28.0	10.6	8.4	5.3	27.6	9.6	6.0	27.0	6.6	4.0	11.0	6.5	3.70	5.30	4.18
	Max	7.0	47.3	35.9	12.1	5.0	33.6	34.5	13.5	10.4	7.4	34.1	11.7	8.0	33.6	8.9	5.4	13.6	7.0	4.24	5.58	4.49
	n=	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Pipistrellus inexpectatus																						
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>1</sup> -M <sup>3</sup>	C-M <sup>3</sup>	
♀	5.3	46.8	35.1	11.9	4.8	32.6	31.6	12.1	11.4	5.2	30.4	10.8	8.8	30.1	8.0	6.4	13.3	5.6	3.98	5.32	4.42	
♀	5.5	47.2	37.3	11.9	5.0	32.8	31.3	12.5	10.5	6.8	30.8	10.5	8.8	30.1	7.7	6.1	13.2	5.8	3.96	5.21	4.51	

Table 12/1. Measurements of Vespertilionidae from Burkina Faso.



<i>Pipistrellus nanulus</i>																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂ (AD) USNM																					
454669	4.0	44	25	9		[26.4]											8.9	4.6	3.64	4.85	3.90
<i>Pipistrellus rusticus</i>																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
X	4.0	42.0	31.1	10.9	4.8	27.5	27.3	9.9	7.8	5.5	27.0	9.0	6.2	26.5	6.5	3.6	10.1	5.5	3.80	5.09	4.04
± SD		3.6	6.8	0.8	0.4	1.1	0.4	0.5	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.6	0.7	0.4	0.03	0.06	0.08
♂♀ Min	3.8	38.1	26.8	10.0	4.2	26.1	26.5	9.1	7.2	4.8	26.4	8.4	5.8	26.2	6.1	2.8	8.5	5.0	3.76	5.02	3.92
Max	4.5	47.3	46.1	12.2	5.3	29.9	27.9	10.6	8.1	6.0	27.6	9.4	6.8	27.2	6.9	4.2	10.7	6.2	3.86	5.16	4.12
n=	4	6	6	6	6	7	6	6	6	6	6	6	6	6	6	6	7	7	5	5	5
<i>Scotoecus albobfuscus</i>																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂	8.0	60.6	32.9	11.7	4.9	31.7	32.6	11.9	8.5	6.0	32.1	10.9	6.3	31.0	6.8	4.4	11.9	8.5	4.79	6.47	4.97
♂	8.5	60.2	31.5	11.9	4.8	33.9	31.6	11.4	8.7	5.2	31.5	10.2	6.6	30.6	8.0	4.6	12.7	6.6	5.32	7.04	5.36
X	7.6	56.4	33.6	11.6	4.4	30.5	30.4	11.5	8.7	6.4	30.2	10.6	6.9	29.0	7.9	4.4	11.9	7.3	4.54	6.46	4.75
± SD	0.4	3.4	1.1	0.4	0.3	0.3	0.9	0.3	0.3	0.3	1.4	0.3	0.5	1.2	0.4	0.3	0.3	0.6	0.06	0.07	0.11
♀♀ Min	7.0	50.3	32.3	11.2	4.0	30.2	29.5	11.1	8.4	6.1	29.1	10.2	6.4	28.1	7.4	4.1	11.6	6.4	4.44	6.34	4.56
Max	8.0	60.3	35.2	12.2	5.0	31.1	32.1	11.9	9.1	6.7	32.9	11.0	7.7	31.3	8.5	4.9	12.2	8.1	4.62	6.54	4.87
n=	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
<i>Scotoecus hirundo</i>																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂	10.8	51.4	35.8	13.8	5.2	33.7	32.1	12.0	9.3	6.4	32.0	11.4	6.8	31.8	7.4	5.1	12.7	8.0	4.65	6.82	5.59
♂	9.0	51.2	32.2	12.8	4.5	32.8	33.3	11.2	9.2	6.5	32.5	11.0	6.4	31.9	7.3	5.2	12.2	8.1	5.12	6.59	5.06
X	10.7	51.8	32.5	13.0	4.8	32.2	31.6	11.3	8.7	6.3	31.2	11.1	6.8	30.3	7.4	4.9	11.7	7.7	4.86	6.57	5.07
Min	9.5	50.0	32.5	12.7	4.4	30.9	30.8	11.2	8.2	5.7	30.5	10.8	6.0	30.0	7.2	4.3	11.3	6.6	4.71	6.44	4.98
Max	11.8	52.6	32.6	13.5	5.2	33.3	33.0	11.5	9.0	7.1	32.1	11.4	7.3	30.8	7.5	5.5	11.9	8.4	4.94	6.84	5.13
n=	4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
<i>Scotophilus dinganii</i>																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♀	26.0	73.8	56.7	20.1	10.4	56.7	56.3	19.9	16.2	8.1	55.3	15.3	10.1	50.6	10.3	6.5	24.0	10.8	7.66	9.74	7.52
♀	27.5	74.6	61.4	18.5	7.7	55.7	56.4	20.8	15.8	8.2	50.9	15.4	10.8	49.9	9.7	7.9	24.7	13.0	7.72	9.98	7.41
<i>Scotophilus leucogaster</i>																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
♂♂ X	20.3	67.0	47.9	14.5	7.4	49.6	46.2	16.9	14.1	7.8	45.8	12.9	8.8	42.5	8.7	5.7	19.4	9.1	6.39	8.37	6.32
± SD	1.4	2.1	2.6	0.9	0.5	1.1	0.9	0.7	0.7	0.4	0.9	0.5	0.8	1.0	0.5	0.7	1.1	0.5	0.19	0.20	0.18
Min	18.0	62.9	43.1	13.2	6.2	47.7	44.4	15.5	12.3	7.2	43.4	12.0	7.2	40.6	7.9	4.5	17.4	8.6	6.06	8.05	6.03
Max	22.5	70.8	51.6	16.1	8.2	52.0	48.3	18.4	15.4	8.5	46.8	13.9	11.1	44.4	9.6	7.0	20.8	10.2	6.73	8.80	6.66
n=	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
X	23.0	70.0	48.8	14.6	7.6	51.2	48.0	17.4	14.1	8.2	47.4	13.2	8.9	44.8	9.2	5.8	19.6	9.3	6.37	8.35	6.18
± SD	3.2	3.2	3.0	0.8	0.4	1.4	1.5	0.6	0.6	0.5	1.6	0.5	0.6	1.5	0.5	0.7	1.0	0.6	0.15	0.17	0.15
♀♀ Min	18.3	63.1	42.9	13.1	6.8	48.1	45.9	16.3	13.2	7.3	44.0	12.3	7.9	42.7	8.5	4.4	18.2	8.2	6.10	8.09	6.00
Max	33.0	80.2	54.3	15.8	8.3	54.2	53.0	18.5	15.8	8.9	51.9	14.5	11.1	49.2	10.3	7.5	21.6	10.5	6.69	8.83	6.58
n=	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
<i>Scotophilus viridis</i>																					
Sex	BM	TL	T	E	TR	FA	3Met	3Ph1	3Ph2	3Ph3	4Met	4Ph1	4Ph2	5Met	5Ph1	5Ph2	TB	HF	C-C	M <sup>2</sup> -M <sup>3</sup>	C-M <sup>3</sup>
X	14.1	59.9	47.0	14.6	7.1	45.3	42.2	15.4	12.6	7.3	41.4	11.9	7.9	39.1	8.1	5.0	18.5	8.9	5.68	7.75	5.72
± SD	3.2	1.9	2.1	0.6	0.4	1.0	1.7	0.5	0.7	0.6	1.4	0.7	0.5	1.6	0.5	0.6	0.5	0.9	0.16	0.20	0.11
♂♂ Min	10.0	57.1	43.1	13.8	6.5	43.6	40.0	14.1	11.0	5.8	39.2	10.4	7.0	37.1	7.3	4.1	17.4	7.3	5.40	7.37	5.55
Max	23.5	64.5	51.1	15.6	7.9	47.4	46.8	16.3	13.6	8.0	45.2	12.9	8.9	43.1	9.3	6.1	19.3	10.2	6.01	8.06	5.91
n=	17	17	17	17	16	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
X	16.7	60.8	48.1	14.6	7.2	45.3	42.3	15.6	13.0	7.4	42.2	12.3	8.4	39.3	8.6	5.1	17.3	8.9	5.75	7.73	5.80
± SD	2.6	1.9	3.0	0.7	0.4	1.1	1.7	0.7	0.4	0.6	1.9	0.4	0.8	1.6	0.4	0.5	1.0	0.8	0.10	0.14	0.14
♀♀ Min	11.0	58.4	43.4	13.9	6.3	43.5	40.5	14.2	12.3	6.7	40.1	11.5	7.0	37.7	8.1	4.5	16.3	8.1	5.65	7.52	5.56
Max	20.3	63.2	52.4	15.7	7.6	46.4	45.6	16.8	13.7	8.3	45.4	12.8	9.6	42.6	9.1	6.0	19.2	10.4	5.90	8.00	6.05
n=	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7

Table 12/2. Measurements of Vespertilionidae from Burkina Faso.

urements of *P. inexpectatus* are larger than the maximum measurements of *P. rutilus* (Table 12).

Genus *Scotoecus* Thomas, 1901

*Scotoecus albofuscus* (Thomas, 1890)

*Scotoecus albofuscus* is located in the extreme Southwest in the South-Sudanian zone (Fig.10). All specimens have been captured near rock formations and in the presence of water in the cliffs of Banfora, next to a water point near hills and in shrubby savanna between a mountain and a dam. Their presence seems to be linked to the topography and the presence of water.

Body and cranial measurements do not help to clearly separate males from females. Only the forearm and cranial measurements (CC and MM) of males is higher than the maximum values of females (Table 12).

*Scotoecus hirundo* (de Winton, 1899)

*Scotoecus hirundo* is located in the extreme Southwest in the South-Sudanian zone (Fig.10). The specimens have been captured in a gallery forest located along a stream and in a woody savanna in the protected forest of Peni. Like *S. albofuscus*, *S. hirundo* inhabits open woodlands (Hill, 1974).

Measurements of body and cranial measurements do not help to distinguish *S. hirundo* from *S. albofuscus* and cannot also help to distinguish males from females (Table 12). Nevertheless, the maximum values of cranial measurements (CC and CM) of female from *S. albofuscus* are below the minimum values of cranial measurements from *S. hirundo*. Especially the white wings of *S. albofuscus* contribute to distinguish them.

Genus *Scotophilus* Leach, 1821

*Scotophilus dinganii* (A. Smith, 1833)

Specimens have been captured in the extreme Southwest in the South-Sudanian zone (Fig. 10). Indeed, *Scotophilus dinganii* is found in most areas of savanna vegetation, from large forests until the beginning of Sahelian savannas (Robbins et al., 1985).

It is the largest *Scotophilus* found in Burkina Faso. Measurements of the forearm reveal that it is larger than *S. leucogaster* and *S. viridis* (Table 12).

*Scotophilus leucogaster* (Cretzschmar, 1826)

Commonly encountered species, *Scotophilus leucogaster* is widespread and present in almost all vegetation zones except in the South-Sahelian zone (Fig. 10).

It is smaller than *S. dinganii*. The averages of body measurements (except 3Ph3) and averages of cranial measurements of *S. leucogaster* are below the measurements of *S. dinganii*. However, there is an overlap, because all the maximum values of *S. leucogaster* (BM, HB, 3Ph2, 3Ph3, 4 Met, 4Ph2, 5Ph1 and 5Ph2) are not inferior to the measurements of *S. dinganii*. However, all the maximum values of the forearm and cranial measurements of *S. leucogaster* are lower than the measurements of the forearm and cranial measurements of *S. dinganii* (Table 12). The measurement of forearm and cranial measurements are better suited to differentiate them. The averages of body measurements (except 3Ph2) of males are smaller than those of females. However, the averages of cranial measurements of males are higher than those of females. Among insectivorous bats this is the most widespread species in Burkina Faso.

*Scotophilus viridis* (Peters, 1852)

*Scotophilus viridis* is present in all areas of African savanna but absent or rare in the driest areas of Sudanian and Sahelian savannas (Robbins et al., 1985). Indeed, In Burkina Faso, it is present only in the Sudanian zone (Fig. 11). It is therefore less widespread than *S. leucogaster*.

It is the smallest of *Scotophilus* found in Burkina Faso (Table 12). The averages of body measurements (except Ear, FA, Tib and HF) and cranial measurements (except MM) of males are smaller than those of females. They do not really help to separate them. The averages of body measurements (except Ear) and cranial measurements of *S. viridis* are lower than those of *S. leucogaster*. However, only maximum values (FA, CC and CM) of males from *S. viridis* are below the minimum values of males from *S. leucogaster*. In addition, only the maximum values (FA, 3 Met, CC and MM) of females from *S. viridis* are below the minimum values of females from *S. leucogaster*. The measurement of the forearm remains the best measurement to separate the two species.



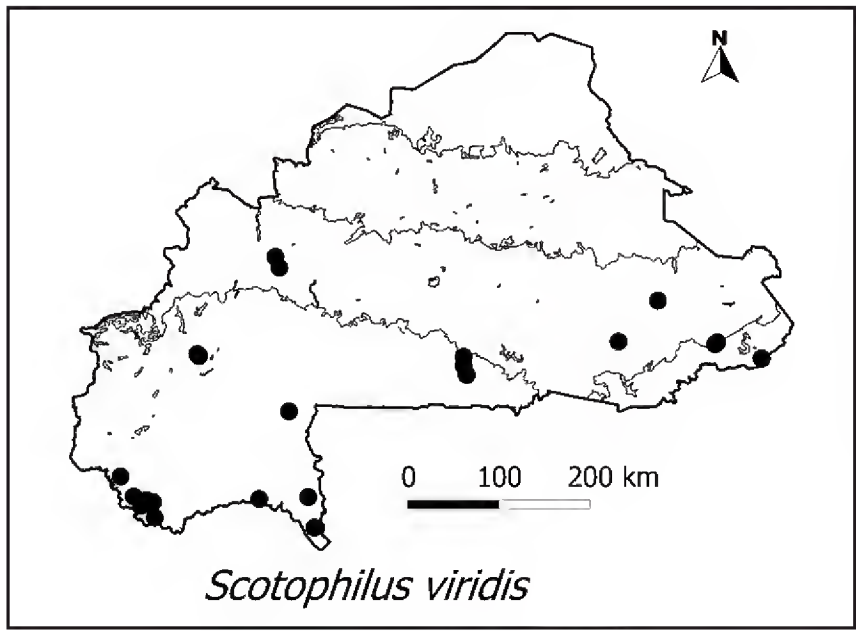


Figure 11. Distribution of *Scotophilus viridis* in Burkina Faso.

Distribution at the family level

The families Pteropodidae, Hipposideridae, Emballonuridae, Nycteridae and Molossidae were present in all phytogeographic areas in Burkina Faso. However, Rhinolophidae were absent in the North-Sahelian zone but present in the rest of the

country. Similarly, Vespertilionidae were absent in the south-Sahelian zone but present in the rest of the country. Rhinopomatidae were only present in the extreme north and the extreme south of the country, while Megadermatidae were present in the Sudanian zone only. Of the 51 species found in Burkina Faso, only 3 species are exclusively located in the Sahelian zone against 32 in the Sudanian zone. The remaining 16 species are found both in the Sahelian and Sudanian areas (Table 13).

DISCUSSION

Of the 36 species already reported since the late 1980s, five species were not captured again and other 15 species have been identified for the first time in Burkina Faso (Kangoyé et al., 2012). Most specimens have been captured in the southern part of the country with a particular emphasis on the Southwest which had been under-sampled. Among the five species already reported in Burkina Faso

Species	Phytogeographic zones		Species	Phytogeographic zones		Species	Phytogeographic zones			
	Sudanian zone only			Sahelian zone only			Sahelian and Sudanian zones			
<i>Pipistrellus nanulus</i>	NSud		<i>Asellia tridens</i>	NSah		<i>Epomophorus gambianus</i>	NSah	SSah	NSud	SSud
<i>Micropteropus pusillus</i>	NSud	SSud	<i>Rhinopoma microphyllum</i>	NSah		<i>Hipposideros ruber</i>	NSah	SSah	NSud	SSud
<i>Nanonycteris veldkampii</i>	NSud	SSud	<i>Glauconycteris variegata</i>		SSah	<i>Nycteris macrotis</i>	NSah	SSah	NSud	SSud
<i>Hipposideros jonesi</i>	NSud	SSud				<i>Nycteris thebaica</i>	NSah	SSah	NSud	SSud
<i>Hipposideros vittatus</i>	NSud	SSud				<i>Chaerephon pumilus</i>	NSah	SSah	NSud	SSud
<i>Lavia frons</i>	NSud	SSud				<i>Eidolon helvum</i>	NSah		NSud	SSud
<i>Rhinolophus fumigatus</i>	NSud	SSud				<i>Chaerephon major</i>	NSah		NSud	SSud
<i>Nycteris hispida</i>	NSud	SSud				<i>Neoromicia guineensis</i>	NSah		NSud	SSud
<i>Chaerephon nigeriae</i>	NSud	SSud				<i>Nycticeinops schlieffenii</i>	NSah		NSud	SSud
<i>Mops condylurus</i>	NSud	SSud				<i>Scotophilus leucogaster</i>	NSah		NSud	SSud
<i>Neoromicia somalica</i>	NSud	SSud				<i>Taphozous perforatus</i>	NSah	SSah		SSud
<i>Pipistrellus rusticus</i>	NSud	SSud				<i>Hipposideros tephurus</i>		SSah	NSud	SSud
<i>Scotophilus viridis</i>	NSud	SSud				<i>Rhinolophus landeri</i>		SSah	NSud	SSud
<i>Hypsignathus monstrosus</i>		SSud				<i>Nycteris gambiensis</i>		SSah	NSud	SSud
<i>Lissonycteris angolensis</i>		SSud				<i>Rhinopoma cystops</i>	NSah			SSud
<i>Rousettus aegyptiacus</i>		SSud				<i>Taphozous nudiventris</i>	NSah			SSud
<i>Hipposideros abae</i>		SSud								
<i>Hipposideros cyclops</i>		SSud								
<i>Rhinolophus alcyone</i>		SSud								
<i>Coleura afra</i>		SSud								
<i>Nycteris grandis</i>		SSud								
<i>Mops demonstrator</i>		SSud								
<i>Mops midas</i>		SSud								
<i>Myotis bocagii</i>		SSud								
<i>Neoromicia capensis</i>		SSud								
<i>Neoromicia nana</i>		SSud								
<i>Neoromicia rendalli</i>		SSud								
<i>Pipistrellus deserti</i>		SSud								
<i>Pipistrellus inexpectatus</i>		SSud								
<i>Scotoecus albofuscus</i>		SSud								
<i>Scotoecus hirundo</i>		SSud								
<i>Scotophilus dinganii</i>		SSud								
32			3			16				

Table 13. Distribution of bats species by phytogeographic zone. NSah: North-Sahelian, SSah: South-Sahelian, NSud: North-Sudanian, SSud: South-Sudanian.

and which have not been captured during 2002 to 2009, two species of whom *A. tridens* and *R. microphyllum* are reported only in the North-Saharan zone. *Hypsignathus monstrosus* although present in the South-Sudanese zone has not been captured. In addition, *M. midas* and *P. deserti*, two species captured previously next to the river Nazinon have not also been captured. *Pipistrellus nanulus* although already collected by the Smithsonian Institution African Mammal Project and present at USNM, had yet been published later by African Chiroptera Report, 2006. Although it had not been captured during this study.

The 15 new species captured between 2002 to 2009 are: *N. veldkampii* and *R. aegyptiacus* (Pteropodidae); *C. afra* (Emballonuridae); *R. alcyone* (Rhinolophidae); *H. cyclops* (Hipposideridae); *C. nigeriae* and *M. condylurus* (Molossidae); *N. grandis* (Nycteridae); *G. variegata*, *N. capensis*, *N. rendalli*, *P. inexpectatus*, *S. albofuscus*, *S. hirundo* and *S. dinganii* (Vespertilionidae).

*Hipposideros cyclops*, *N. grandis* and *R. alcyone* are forest species. They are located in the extreme south-western Burkina Faso, where there are the wettest areas of the country. *Nanonycteris veldkampii*, is also a forest species that is found in Burkina Faso during rainy seasons only. Although *P. nanulus* is a forest species, the only specimen collected thus far comes from the Centre. *Roussetus aegyptiacus* and *C. afra* are cavernicolous species. They are both located in the South and have all been captured in rock formations that constitute their resting places. *Chaerephon nigeriae* and *M. condylurus*, although they are synanthropic species because of the fact that they are often found in homes have been only located in the South. *Neoromicia capensis*, *N. rendalli*, *P. inexpectatus*, *S. albofuscus*, *S. hirundo* and *S. dinganii* are species of moist savannas. They are all located in the Southwest in the South-Sudanese zone except *N. rendalli* which is located in the Southeast. As for *G. variegata*, also a species of humid savannas, it is present in the North-Sudanese zone.

After this study, a total of 51 species were found in Burkina Faso. And, compared with other countries, the diversity of bats in Burkina Faso can be described as being average. In countries like Ivory Coast, where we find 87 species of bats (J. Fahr unpublished data), Ghana, 86 species (Weber & Fahr, 2007) and Cameroon, 72 species (Bakwo,

2009) diversity can be explained by the fact that these countries are near the coast. In addition to the forest areas, these countries, also have the Guinean zone. And this Guinean zone is a transition zone that contains a wide variety of species (Fahr & Kalko, 2010). This study helped to collect many new pieces of information on the distribution of many species. However, studies using different capture methodologies are needed to obtain complete inventories of the diversity of bats (Kalko et al., 1996; Bergallo et al., 2003) and as already noted by Kalko (1997), insectivores are species which are difficult to capture and the combination of several methods particularly acoustic methods are used to identify them at the species level (Kalko & Handley, 2001). It would therefore not be surprising to capture other species in Burkina Faso so as to contribute more to a better understanding of the ecology of bats for better conservation approaches.

*Epomophorus gambianus*, *H. ruber*, *N. macrootis*, *N. thebaica* and *C. pumilus* are species that have a wider distribution across Burkina Faso, as they have been captured in all phytogeographic areas. These species are also widely distributed in West Africa (African Chiroptera Report, 2012).

*Eidolon helvum*, *T. perforatus*, *C. major*, *N. schlieffenii*, *N. guineensis* and *S. leucogaster* have atypical distributions. *Eidolon helvum*, *C. major*, *N. schlieffenii*, *N. guineensis* and *S. leucogaster* are present everywhere except in south-Saharan zone. About *T. perforatus*, it is present everywhere except North-Sudanese zone. Seen how these species are distributed in Burkina Faso, they should all be present on the entire territory of Burkina Faso.

*Hipposideros tephrosus*, *R. landeri* and *N. gambiensis* are located in all phytogeographic areas except in the North-Saharan zone. It is in fact, species that are often encountered in savanna (Koch-Weser, 1984; Van Cakenberghe & De Vree, 1998).

Species located in two phytogeographic areas (*M. pusillus*, *N. veldkampii*, *H. jonesi*, *H. vittatus*, *L. frons*, *R. fumigatus*, *N. hispidus*, *C. nigeriae*, *M. condylurus*, *N. somalica*, *P. rusticus* and *S. viridis*) are mainly present in the Sudanese zone except *T. nudiventris* and *R. cystops* which have been located in extreme north and extreme south of the country.

Most bats species present in Burkina Faso, 23 in total (*A. tridens*, *R. microphyllum*, *G. variegata*, *P. nanulus*, *H. monstrosus*, *L. angolensis*, *R. aegyptiacus*, *H. abae*, *H. cyclops*, *R. alcyone*, *C. afra*, *N.*



*grandis*, *M. demonstrator*, *M. midas*, *M. bocagii*, *N. capensis*, *N. nana*, *N. rendalli*, *P. deserti*, *P. inexpectatus*, *S. albofuscus*, *S. hirundo* and *S. dinganii*) are rarely captured. Probably these species have small populations and restricted distributions within the country because they are found in only one of the four phytogeographical areas. The majority of these species (19) is located in South-Sudanian zone against one in North-Sudanian (*P. nanulus*) area, one in the southern Sahelian zone (*G. variegata*) and two in the North-Sahelian zone (*A. tridens* and *R. microphyllum*). Above 60% of Burkina Faso is under the influence of Sudanian climate (Ministère de l'Environnement et de l'Eau, 1999) including the Centre and South. This can explain partly that 32 of the 51 species found in Burkina Faso, are exclusively recorded in the Sudanian zone. Nevertheless, favorable climatic conditions in South-Sudanian zone of Burkina Faso are the real reason of the higher species diversity in this area. Rough conditions in the Sahelian zone justify that only 3 species are exclusives of this area. Nevertheless 16 other species were found in this area (as well as in the Sudanian zone), proving that this area can provide suitable habitats, shelter, water and food for important diversity of bats species. Exclusive species indicated the importance in biodiversity conservation of this area, generally neglected in conservation programs.

This study has allowed us to highlight the geographical distribution of bats in Burkina Faso. Although bats were captured in all phytogeographic areas in Burkina Faso, distribution patterns change depending on species and even families. Results highlight the importance of each phytogeographic area as unique habitat for some species. It is then important, for conservation and management, to give equal consideration to each area. Habitats condition is likely the factor influencing the species distribution. A further step in bat studies in Burkina Faso could be the modeling of species distribution based on environmental variables, which could give some useful information for species management.

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## Effects of climate changes on agriculture

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### ABSTRACT

This paper reviews literature concerning a wide range of processes through which climate change could potentially impact agriculture. Agriculture is strongly influenced by weather and climate and, at present, the aggregate impacts of climate change on global-scale agricultural productivity cannot be reliably quantified.

### KEY WORDS

agriculture; climate; climate change.

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### INTRODUCTION

Climate change has many elements, affecting biological and human systems in different ways. Global average temperature increases mask considerable differences in temperature rise between land and sea and between high latitudes and low; precipitation increases are very likely in high latitudes, while decreases are likely in most of the tropics and subtropical land regions (IPCC, 2007).

Climate change is inevitably resulting in changes in climate variability and in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events (IPCC, 2012). Changes in climate variability and extremes can be visualized in relation to changes in probability distributions, shown in figure 1 (IPCC, 2012). Current observations and climate projections suggest that one of the most significant impacts of climate change is likely to be on the hydrological system, and hence on river flows and regional water resources (Strzepek & McCluskey, 2007; Bates et al., 2008).

Principal climate variables affecting water availability are precipitation, temperature and potential evaporation. Precipitation is the source of all fresh-

water resources and determines the level of soil moisture, which is essential in the formation of runoff and hence river flow. Soil moisture is determined not only by the volume and timing of precipitation, but also by a complex interaction and feedbacks with evaporation and temperature (IPCC, 2001). Consequently, the likely impacts of climate change on the agricultural sector have prompted concern over the magnitude of future global food production (Bindi & Olesen, 2000).

### DISCUSSION

#### *Effects of increased temperatures*

Temperature often determines the potential length of the growing seasons for different crops, and generally has a strong effect on the timing of the development processes and on the efficiency with which solar radiation is used to make plant biomass (Monteith, 1981). Recent increases in climate variability may have affected crop yields in countries across Europe since around the mid-1980s (Porter & Semenov, 2005) causing higher inter-

annual variability in wheat yields. Changes in short-term temperature extremes can be critical, especially if they coincide with key stages of development. Only a few days of extreme temperature at the flowering stage of many crops can drastically reduce yield (Wheeler et al., 2000).

Bryant et al. (2008) report the change of Corn Heat Units under climate change scenarios in their analysis on the economic impacts of climate change on cash crop farms in Québec. Wollenweber et al.,

(2003) found that the plants experience warming periods as independent events and that critical temperatures of 35.8 °C for a short-period around anthesis had severe yield reducing effects. However, high temperatures during the vegetative stage did not seem to have significant effects on growth and development.

In general, the conclusion is that increased mean annual temperatures in mid- to high-latitude regions, if limited to one to three degrees, across a range of CO<sub>2</sub> concentrations and rainfall changes can have a small beneficial effect on the main cereal crops, notwithstanding that such simulations are highly uncertain (IPCC, 2007).

### Effects of rainfall

Climate changes remote from production areas may also be critical. Irrigated agricultural land comprises less than one-fifth of all cropped area but produces between 40 and 45 per cent of the world's food (Döll & Siebert, 2002), and water for irrigation is often extracted from rivers which depend upon distant climatic conditions.

With no change in precipitation (or radiation), slight warming (+1°C) might reduce average yields by about 5-4%; and a 2°C warming might reduce average yields by about 10-7%. In addition, reduced precipitation could also decrease yields of wheat and maize in these breadbasket regions. A combination of increased temperatures (+2°C) and reduced precipitation could lower average yields by over a fifth (Warrick et al., 1986). In a study looking at the impacts of current climate variability, Kettlewell et al. (1999) showed that heavy rainfall in August was linked to lower grain quality which leads to sprouting of the grain in the ear and fungal disease infections of the grain.

### Effects of CO<sub>2</sub> fertilisation

Increases in CO<sub>2</sub> concentration would increase the rate of plant growth. A doubling of CO<sub>2</sub> may increase the photosynthetic rate by 30 to 100%, depending on other environmental conditions such as temperature and available moisture (Pearch & Bjorkman, 1983).

As well as influencing climate through radiative forcing, increasing atmospheric CO<sub>2</sub> concentrations can also directly affect plant physiological pro-

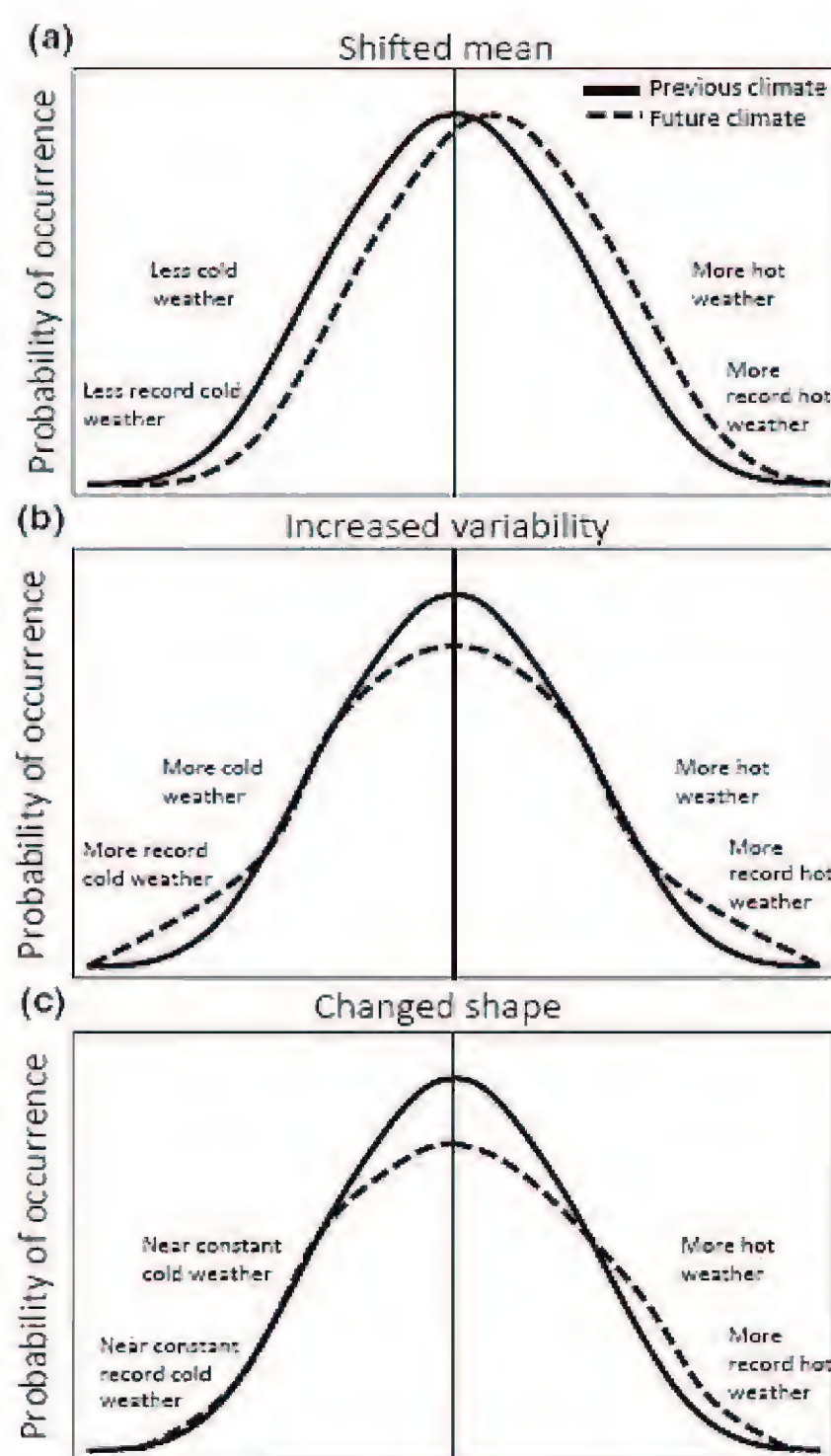


Figure 1 The effect of changes in temperature distribution on extremes. Different changes of temperature distributions between present and future climate and their effects on extreme values of the distributions: (a) Effects of a simple shift of the entire distribution towards a warmer climate; (b) effects of an increase in temperature variability with no shift of the mean; (c) effects of an altered shape of the distribution, in this example a change in asymmetry towards the hotter part of the distribution. From IPCC (2012).



cesses of photosynthesis and transpiration (Field et al., 1995). Therefore any assessment of the impacts of CO<sub>2</sub>-induced climate change on crop productivity should account for the modification of the climate impact by the CO<sub>2</sub> physiological impact. Many studies suggest yield rises owing to this CO<sub>2</sub>-fertilization effect and these results are consistent across a range of experimental approaches including controlled environment closed chambers, greenhouse, open and closed field top chambers, and free-air carbon dioxide enrichment experiments (Tubiello, 2007). Despite the potential positive effects on yield quantities, elevated CO<sub>2</sub> may, however, be detrimental to yield quality of certain crops. For example, elevated CO<sub>2</sub> is detrimental to wheat flour quality through reductions in protein content (Sinclair et al., 2000). There are, however, important differences between the photosynthetic mechanisms of different crops and hence in their response to increasing levels of CO<sub>2</sub>.

#### *Effects on pest and diseases*

Studies suggest that temperature increases may extend the geographic range of some pests currently limited by temperature. In cool temperate regions, where insect pests and diseases are not serious at present, damage is likely to increase under warmer conditions. Fungal and bacterial pathogens are also likely to become more severe in areas where precipitation increases (Zhou et al., 1995).

Indications suggest that pests, such as aphids and weevil larvae (Staley & Johnson, 2008), respond positively to elevated CO<sub>2</sub>. Increased temperatures also reduced the overwintering mortality of aphids enabling earlier and potentially more widespread dispersion (Zhou et al., 1995). Over the next 10–20 years, disease affecting oilseed rape could increase in severity within its existing range as well as spread to more northern regions where at present it is not observed (Evans et al., 2008).

#### *Adaptation to climate change*

Smith (1997) distinguishes between anticipatory and reactive adaptation, in which anticipatory adaptation forecasts climate change and acts before it unfolds, while reactive adaptation changes behaviour only after climate change has taken place. According to Mendelsohn (2010), efficient adaptation

results in the actual net damages (damages minus the cost of adaptation) being less than the potential damages from climate change. Thus, if farmers adapt their behaviour to new climatic conditions, then the net impact to the farm and the sector can be lessened. Adaptation through cropping pattern change can in some cases ease the exposure of plants to critical higher temperatures; for example by introducing winter types that may benefit from, or are less susceptible to, higher temperatures (Peltonen-Sainio et al., 2011). As regards precipitation changes and water shortage, farmers can adjust by improving soil water-holding capacity by adding crop residues or manure, or by adopting conservation tillage such as reduced tillage or no-till (Smith & Olesen, 2010).

## CONCLUSIONS

An increase in mean temperature can be confidently expected, but the impacts on productivity may depend more on the magnitude and timing of extreme temperatures. Agricultural impacts in some regions may arise from climate changes in other regions, owing to the dependency on rivers fed by precipitation, snowmelt and glaciers some distance away. Few studies have assessed the response of crop yields to CO<sub>2</sub> fertilization under actual growing conditions, and consequently model projections are poorly constrained.

All these results are subject to significant uncertainties under the most likely climate change. A strong incidence of extreme events could increase the variability of production in a way that is not captured by the standard estimations in the literature. Farmers may significantly adapt farming practices, or different degrees of adaptation to climate change could be observed.

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# Contribution to the knowledge of the Longhorn Beetles (Coleoptera Cerambycidae) of the Syrian Coastal Region

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## ABSTRACT

51 species including 10 subspecies belonging to 37 genera from 25 tribes are reported from the Syrian Coastal Region (SCR). Nine species were recorded for the first time in Syria. The status of 2 subspecies previously recorded was considered doubtful, and alternatives were suggested. Modern classification of the identified species is given; type species and some synonyms of taxa are also mentioned. A checklist of Cerambycidae fauna of the SCR is suggested. This knowledge of the Cerambycidae in SCR was a result of the study and examination of a total of 1224 specimens collected from 173 sites distributed across the different areas of the SCR during the period from 2011 until 2014. Collected specimens were prepared, examined, and then identified. All specimens were curated and permanently preserved in Entomology Laboratory of Tishreen University. Available chorotypes, distribution ranges of the identified species are provided; relating remarks, personal observations, and, sometimes, suggestions are also supplied.

## KEY WORDS

Syria; Syrian Coastal Region; Cerambycidae; new data; faunistics.

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## INTRODUCTION

The Syrian Coastal Region (SCR) is considered as the most important region of Syria, providing a narrow window to the Mediterranean Sea, and featuring an ideal Mediterranean environment, with mildly cold winters, and relatively hot and dry summers. These environmental characteristics combined with fertile plains that stretch from sea level and elevate gradually up to higher hills and, eventually, relatively high mountains, associated with a highly diversified flora, provide SCR with rather various ecological niches that host rich fauna communities.

Among the Syrian fauna, insects comprise a major component, with Coleoptera at a high-profile

status of biodiversity. Coleoptera, generally speaking, is the largest group of insects, including families of worldwide distribution (Gillot, 2005). Cerambycidae, more commonly known as “Longhorn Beetles”, is considered as one of the largest and most diverse families in Coleoptera, with more than 35000 described species included in approximately 4000 genera with global ranges of distribution (Hanks, 1999; Alekseev, 2007; Evans et al., 2007). The distinctively high diversity of longhorn beetles is more accentuated by the great variance in their morphology, size, and coloration, which implies a corresponding variance in life histories and host plant preferences as well (Twinn & Harding, 1999; Paulino-Neto et al., 2005; Teledo et al., 2007).

Although Cerambycidae beetles reveal a primary affinity to tropical and subtropical regions, they do, in fact, inhabit almost all zoogeographical regions of the planet (de Vaio et al., 1985; Awal, 2005). In general, climatic factors in association with the availability of suitable host plants act as the main factors that determine the distribution of this Family in the world today (Linsley, 1959). Furthermore, behavior and reproductive strategies of the adults are shaped by the host requirements of the larval stages, with which the host plant conditions are closely correlated (Hanks, 1999).

All Family members are phytophagous, with different host plant preferences among species and genera (Bily & Mehl, 1989). Larval Cerambycidae of most species (86%) are xylophagous (e.g. feeding inside living, moribund, or even decomposing wood), while, in some certain species (14%), larvae feed in stems or roots of some herbaceous plants (Susana, 2009; Gnjatovic & Zikic, 2010). These feeding habits emphasize not only the economic importance of this family (e.g. being pests of heavy damage) in agricultural ecosystems, but also their ecological importance (e.g. serving as wood decomposers) in natural ecosystems as well (Paulino-Neto et al., 2005; Evans et al., 2007). Furthermore, Cerambycidae are considered as potentially significant indicators for the forest health and biodiversity (Allison et al., 2004). In this accord, the changes in some silviculture practices have led to a sheer decline in the populations of some certain species, especially in Europe, which rendered some species endangered, and, accordingly; many species were red-listed (Evans et al., 2007).

It is now established that taxonomy, biology, and biogeography of Cerambycidae are well studied in Europe and North America (Allison, 2004); however, the knowledge of this family in the Eastern Mediterranean, specifically the Far East, is still inchoate, but more attention has been drawn towards this diversity-rich region recently (Cowling et al., 1996; Sama, et al., 2010). In Syria, actually, the knowledge of biology, taxonomy, and biodiversity of longhorn beetles is still not well established, and their complete fauna is far from fully known. In fact, there is a painful dearth in local studies, and the availability of pertinent resources is quite limited. Furthermore, most of the species recorded in Syria have been collected, identified, and accounted for by researchers who come from abroad (Hariri, 1971).

In this study, which comes to be the first of its kind locally, we tried to deduce the biodiversity of Cerambycidae in SCR as much thoroughly as possible, in an attempt to bridge some of the gaps that hinder a broader knowledge of their taxonomy, and status in addition to clarifying some vague aspects about their biodiversity and zoogeographical affinity as a stepping stone towards the knowledge of Cerambycidae in the whole of Syrian Arab Republic.

## MATERIAL AND METHODS

### *Study Area*

The Syrian Arab Republic is situated on the eastern coast of the Mediterranean Sea, bordered by Turkey from the north, Iraq from the east, Palestine and Jordan from the south, and by Lebanon and the Mediterranean from the west.

The Syrian Coastal Region (SCR), which is also commonly known as “The Coastal Strip”, is located along the Mediterranean Sea, occupying the western portion of the country. It spans between 35°-45° E, and 36°-43° N with an estimated area of 5100 km<sup>2</sup>, representing less than 2.5% of the Syrian territory.

The Coastal Region is considered as one of the scarce natural resources of Syria, providing a narrow window to the Mediterranean Sea for such a relatively large country, with only 183 km of coastline. From an administrative point of view, the Coastal Region is partitioned into two coastal governorates (provinces), namely: Latakia and Tartus. Each of which consists of areas, arranged in the following order:

- Latakia Province: congregating four areas, namely: Latakia Area; Jableh Area; Qardahah Area; Haffa Area.
- Tartus Province: congregating five areas, namely: Tartus Area, Baniyas Area; Safita Area; Shayk-Badr Area; Draykish Area.

The climate in the Syrian Coastal Region is typically Mediterranean, with dry summers, and wet and windy winters and springs. Annual precipitation ranges between 800-900 mm. The geography is quite heterogenous; the shoreline consists of sandy bays, alternating with rocky headlands and low cliffs. The coastal mountain chains separate



Syria's interior from the Mediterranean coast, with slopes originally covered in forests of oaks (*Quercus* sp.) and pines (*Pinus* sp.). On the coastal slopes of the mountains north to Latakia sprout some of the best natural forests of the country. South to Latakia, the coastal strip widens into fertile plains (Plains of Jableh), to the east of the third major coastal city, Jableh. The strip then narrows again and is interrupted by spurs of the mountains immediate to the east in the sector between Banyias, the fourth coastal city, and Tartous, the second major coastal city. South to Tartus, the narrow coastal strip then widens into the fertile "Sahl 'Akkar" (Plain of 'Akkar), which continues south across the Lebanese border.

### ***Collection, preservation, and identification***

Specimens of adult Cerambycid beetles were collected, by the first author, from different sites and localities scattered all across the different areas of SCR. The study began in 2011 and lasted until the end of 2014, with the sampling process beginning at the first of March and spanning all through the end of December (e.g. 10 months) of each year of study.

Collection techniques and tools were multiple, ranging from the collection by hand, especially for large specimens, to the sweeping of grasses and herbaceous plants with entomological nets, (35 cm in diameter), especially for small specimens. Sweeping and hand-picking were achieved exploiting different plant parts (e.g. trunks, twigs, branches, park, stems, leaves, flowers, ...).

Some other passive sampling techniques were also adopted, with the exploitation of light traps, consisting of light source (e.g. a mercury light bulb 160 Watts) against a white sheet, these structures were set near fruit-tree orchards and forest sites and monitored during the early hours of the evening. Pitfall traps (e.g. open plastic containers amended with a slippery substance i.e. Vaseline) were also applied, specifically in forest sites and fruit-tree orchards. Paired traps fixed to tree branches and hung at 1.5 - 2 m were also applied in some fruit-tree orchards. The structure of these traps was simple, it consisted of a plastic bottle with the upper-third portion cut off, and then inversely glued back to the body of the bottle. A lateral opening was partially carved out with a knife leaving a part attached to the body of the bottle to keep the opening

closed when the trap is in-action, so that the opening could be used for the extraction of the specimens. Different bait compositions were tried, in some traps sweet wine was applied, in others a combination of ripe banana with non-alcoholic beer was used (Chalumeau & Touroult, 2005). Coordinates and elevation were recorded for each collecting site using a GPS device.

Some specimens were collected by chance, i.e. intercepting some samples in Tishreen University Campus, or encountered on walls near light sources during visits to some country houses.

After collection, specimens went through many stages of preparation, identification and, eventually, curation and preservation. First of all, specimens were killed using killing jars charged with NaCN (big specimens), or ethyl acetate (small specimens). After killing, specimens were put in a sealed container with a Styrofoam at the bottom to hold the specimens, then frozen (0° Celsius) for 48-72 h, and sometimes even for a longer period of time. Freezing served as a temporary preserving technique (Triplehorn & Johnson, 2005; Gullen & Cranston, 2010), especially when the number of specimens being prepared for studying was rather high, so that the specimens will be kept intact until the time comes for their handling. Moreover, freezing, as we observed later on, helped in prolonging the "box-life" of specimens in permanent preservation boxes (i.e. no foul smells, and less degradation). After freezing, specimens were pinned using entomological pins (No. 6), then spread on a Styrofoam, then, finally, dried at the room temperature for 5-7 days.

After properly handled and prepared, specimens were examined and identified using KONUS ST-30-2L and NIKON SMZU microscopes. Identification was done according to: Bense (1995), Bily & Mehl (1989), Duffy (1952), Lorenc (1999), Özdikmen & Turgut (2009a, b, c, d, e), Özdikmen & Turgut (2010a,b), Picard (1929), Villiers (1978), Wang & Leschn (2003), Zomoroka & Panin (2011).

Identification was followed by a labeling procedure, and then specimens were transferred to wooden boxes equipped with glass frontal panels for permanent preservation. Every box was amended with Naphthalene pellets and a desiccant material to help prolong the preservation period. All boxes and specimens are kept in the Entomology Laboratory in Plant Protection Department in the Faculty of Agriculture in Tishreen University, Syria.



Due to some fading of specimens' colors, with storage, and due to some pests that might wreak havoc to the specimens, each specimen was pictured by Olympus SP 800 UZ digital camera.

All through the period of this study, we reviewed all available studies relating to Cerambycidae in both Syria and neighboring countries (e.g. Iraq, Jordan, Lebanon, Palestine, and Turkey), to establish a solid background about taxonomy, biodiversity and biogeography of Cerambycid beetles.

## RESULTS AND DISCUSSION

During this study a total of 51 species including 10 subspecies and belonging to 37 genera in 25 tribes were reported.

Reported taxa are listed below. With the following arrangement:

- The classification system follows Danilevsky (2015).
- Collection sites and localities with their geographical data (e.g. latitude, longitude, and altitude) are provided in alphabetical order.
- Chorotype data, when available, are provided and referenced (Villiers, 1978; Katbeh-Bader, 1996; Doychev & Georgiev, 2004; Awal, 2005; Sama, & Rapuzzi, 2006; Sama, 2008; Sama et al., 2010a, b; Sakenin et al., 2011; Dascalu et al., 2012; Peris-Felipo & Jimenez-Peydro, 2012; Ozdikmen, 2014; Danilevsky, 2015).
- Bionomics, when available, are given, based on: Bense (1995), Sama et al. (2010a, b), Hoskovec & Rejzek (2013).
- Remarks, personal observations, and suggestions relating to each taxon are also provided.

Family CERAMBYCIDAE Latreille, 1802

Subfamily Prioninae Latreille, 1802

Tribe Aegosomatini J. Thomson, 1861

Genus *Aegosoma* Audinet-Serville, 1832

Type species: *Cerambyx scabricornis* Scopoli, 1763

1. *Aegosoma scabricorne* Scopoli, 1763

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Ghasaniah, 668.0 m, 36° 7'20.63"E, 35° 3'50.39"N, 5.VI.2013 (1 male, 1 female)/Al-Yaghansah, 31.0 m 35°51'57.75"E, 35°33'20.03"N,

8.XI.2014 (1 male)/Latakia City-Park, 20.0 m, 35°46'51.7"E, 35°31'47.1"N, 20.X.2014 (1 male, 1 female)/Serskieh, 55.0 m, 35°55'10.40"E, 35°42'19.84"N, 16.V.2012 (1 female); 10.V.2013 (1 male). Jableh Area: Helbakko, 1100.0 m, 36°10'5.35"E, 35°20'0.39"N, 12.VIII.2012 (1 female); 4.VI.2014 (2 males).

Tartus Province. Tartus Area: Al-Marana, 578.0 m, 36°5'14.71"E, 35°12'50.69"N, 10.XI.2014 (1 male).

CHOROTYPE. Turano-European (Özdikmen and Turgut, 2009c).

BIONOMICS. Polyphagous on deciduous trees: *Populus*, *Salix*, *Junglans*, *Acer*, *Quercus*, *Alnus*, *Tilia*, *Prunus*, *Platanus*, *Fagus*, *Ulmus*, *Celtis*, *Fraxinus*, *Morus*, *Aesculus*, *Carpinus*, *Castanea*, *Prunus*, *Malus*, *Eucalyptus*; life cycle usually takes 3 years at least; adults are usually encountered between June–August.

REMARKS. Not frequently encountered in SCR, and its distribution covers both lowlands and relatively highlands. In 2014 (uncommonly hot and dry year) a specimen was collected in autumn i.e. November. Most of specimens were from light traps situated near forests of broadleaf trees, and sometimes picked from walls near light sources.

Tribe Ergatini Fairmaire, 1864

Genus *Callergates* Lameere, 1904

Type species: *Ergates gaillardoti* Chevrolat, 1854

2. *Callergates gaillardoti* Chevrolat, 1854

EXAMINED MATERIAL. Latakia Province. Latakia Area: Demsarkho, 17.0 m, 35°46'36.8"E, 35°33'12.6"N, 29.IX.2011 (1 male, 1 female); Serskieh, 55.0 m, 35°55'10.40"E, 35°42'19.84"N, 16.V.2012 (1 male, 1 female). Jableh Area: Ain Al-Dilb, 440.0 m, 36° 3'14.17"E, 35°13'40.87"N, 16. IX. 2012 (1 female)/Besaysin, 29.0 m, 35°57'12.27"E, 35°20'53.43"N 17.X.2013 (1 male).

Tartus Province. Sheik Badr Area: Ash-Shayk Badr, 491.0 m, 36°4'52.70"E, 34°59'25.23"N, 10.IX.2011 (1 female).

CHOROTYPE. E-Mediterranean/Palestino-Taurian (Özdikmen & Turgut, 2009c)

BIONOMICS. Usually monophagous on pine (*Pinus*); life cycle usually takes less than three



years; adults are usually encountered between June–August.

REMARKS. Relatively hard to find, and is a rather rare species in SCR. Specimens were collected by hand from trunks and twigs of pine (*Pinus* spp.) trees, usually in the evening. Its close relative *Ergates faber* (Linnaeus, 1761), which usually accompanies it (Hoskovec & Rejzek, 2013), has never been encountered during the period of this study.

Tribe Macrotomini J. Thomson, 1861

Genus *Prinobius* Mulsant, 1842

Type species: *Prinobius myardi* Mulsant, 1842

### 3. *Prinobius myardi atropos* Chevrolat, 1854

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 13.VIII.2011 (2 females); 16.X.2014 (1 male); 12.XI.2014 (1 male)/Al-Qanjara, 72.45 m, 35°52'25.1"E, 35°30'43.4"N, 16.X.2014 (1 female)/Demsarkho, 17.0 m, 35°46'36.8"E, 35°33'12.6"N, 3.XI.2011 (2 females); 31.XI.2011 (1 male); 13.IX.2012 (1 male)/Mashqita, 88.0 m, 35°53'51.0"E, 35°39'34.1"N, 13.IX.2014 (1 male)/Serskieh, 55.0 m, 35°55'10.40"E, 35°42'19.84"N, 16.IX.2012 (2 females); 18.IV.2012 (1 male)/Zakizkanieh, 54.0 m, 35°48'29.85"E, 35°31'47.30"N, 15.XI.2013 (1 female). Jableh Area: Ain Al-Beida, 6.0 m, 35°53'34.2"E, 35°39'28.7"N, 13.VIII.2011 (1 female); 26.IX.2011 (1 male)/ Bustan Al-Basha: 33.0 m, 35°56'3.35"E, 35°25'26.46"N, 7.X.2013 (2 males)/Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 23.X.2013 (1 male, 1 female); 20.X.2014 (1 female); 25.XI.2014 (2 females)/Ras Al-Ain, 133.0 m, 36°0'38.71"E, 35°19'26.72"N, 19.IX.2012 (2 females). Qardahah Area: Bshilama, 265.0 m, 36°3'35.50"E, 35°26'53.57"N, 7.X.2014 (1 male)/Fakhoura, 183.0 m, 35°58'17.46"E, 35°29'7.54"N, 16.XI.2012 (2 males). Haffa Area: Al-Haffah, 272.0 m, 36° 1'59.38"E, 35°35'41.57"N, 20.IX.2012 (2 females)/Aramo, 821.0 m, 36°8'5.77"E, 35°37'47.77"N, 28.XI.2013 (1 male)/Mzeraah, 515.0 m, 36°4'19.18"E, 35°31'59.55"N, 7.IV.2013 (1 male); 23.X.2014 (1 female); 16.XI.2014 (1 male)/Sirna, 710.0 m, 36°6'24.03"E, 35°36'59.04"N, 27.VIII.2011 (1 female); 5.IX.2012 (1 female)/Shiek Hussamo, 631.0 m, 36°5'46.01"E, 35°35'45.99"N, 13.VII.2013 (1 female).

Tartus Province. Tartus Area: Hosain Al-Bahir, 162.0 m, 35°54'27.30"E, 34°58'57.66"N, 20.IX.2011 (2 females)/Matin Bouria, 240.0 m, 35°57'4.38"E, 35°2'10.67"N, 16.IV.2014 (1 male)/Tartus, 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 25.IX.2013 (2 females). Baniyas Area: Al-Qadmus, 919.0 m, 36°9'40.13"E, 35°6'6.53"N, 13.X.2013 (1 male, 2 females)/ Baniyas, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 11.XI.2012 (2 females)/Kherbet Al-Sansel, 242.0 m, 35°58'20.48"E, 35°10'2.15"N, 1.IX.2012 (2 females); 1.XII.2013 (2 females). Safita Area: Al-Kashfeh, 334.0 m, 35°59'21.61"E, 35°4'52.91"N, 11.VIII.2013 (2 females). Shayk-Badr Area: Ash-Shayk-Badr, 491.0 m, 36°4'52.70"E, 34°59'25.23"N, 13.VIII.2011 (1 male, 1 female); 4.IX.2013 (2 females); 14.XI.2014 (1 male, 1 female)/Blawzeh, 462.0 m, 36°1'5.23"E, 35°8'59.40"N, 25.VIII.2012 (3 females).

CHOROTYPE. W-Palearctic, or Turano-Mediterranean (Özdikmenand & Turgut, 2009c).

BIONOMICS. Polyphagous on deciduous trees: *Acacia*, *Casuarina*, *Ceratonia siliqua* L., *Citrus*, *Eucalyptus*, *Quercus calliprinus* L., *Q. ilex* L., *Q. ithaburensis* Decne., *Q. suber* L., *Pyrus*, *Acer*, *Fraxinus*, *Alnus*, *Morus alba* L., *Olea*, *Populus*, *Platanus*, *Salix*; life cycles usually takes several years; adults are usually encountered between June–August.

REMARKS. Widely spread species, its distribution pattern covers almost all the area of SCR. Specimens were collected by hand, or from the walls near light sources in some countryside houses.

Tribe Prionini Latreille, 1802

Genus *Mesoprionus* Jakovlev, 1887

Type species: *Prionus asiaticus* Faldermann, 1837

### 4. *Mesoprionus lefebvrei* Marseul, 1856

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Yaghansah, 31.0 m, 35°51'57.75"E, 35°33'20.03"N, 2.XI.2014 (1 male)/Baksa, 89.0 m, 35°49'18.33"E, 35°34'15.2"N, 12.IX.2012 (1 male)/Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 24.VI.2011 (2 males); 13.VI.2011 (1 male)/Demsarkho: 17.0 m, 35°46'36.8"E, 35°33'12.6"N, 17.X.2012 (1 male)/Fidio, 36.0 m, 35°51'43.87"E, 35°29'31.46"N, 10.X.2012 (1 male); 15.X.2012 (1 male)/Janatah,



108.0 m, 35°49'49.4"E, 35°35'01.9"N, 1.X.2011 (1 female)/Jbariun, 15.0 m, 35°53'20.43"E, 35°34'22.27"N, 30.VI.2014 (1 male); 9.X.2014 (1 male)/Kamlieh, 242.0 m, 35°54'6.06"E, 35°40'5.31"N, 17.IX.2013 (1 male)/Mashqita, 88.0 m, 35°53'51.0"E, 35°39'34.1"N, 3.VIII. 2012 (1 male, 1 female)/Tisheen University Campus, 31.0 m, 35°48'25.7"E, 35°31'29.0"N, 5.VI.2013 (1 male). Jableh Area: Ain Al-Dilb, 440.0 m, 36°3'14.17"E, 35°13'40.87"N, 16.V.2014 (1 male)/Al-Kalaie: 185.0 m, 36°2'31.34"E, 35°21'17.62"N, 15.VIII.2011 (1 male)/Beit Yashut, 1145.0 m, 36°11'42.93"E, 35°16'41.29"N, 19.IX.2013 (1 male)/Siano, 78.0 m, 35°59'39.73"E, 35°22'12.64"N, 13.XI.2011 (1 male); 10.IX.2014 (2 males); 25.XI.2014 (2 males). Qardahah Area: Al-Qardahah, 310 m, 36°3'36.19"E, 35°27'28.76"N, 13.IX.2014 (2 males)/Istamou, 73 m, 35°54'8.48"E, 35°29'51.27"N, 10.VII.2014 (1 male). Haffa Area: Al-Qastal, 155.0 m, 36°1'14.81"E, 35°39'9.59"N, 30.X.2011 (1 male)/As-Samia, 197.0 m, 35°59'20.56"E, 35°33'16.80"N, 28.VIII.2011 (1 male)/Mzeraah, 515.0 m, 36°4'19.18"E, 35°31'59.55"N, 6.X.2011 (1 female)/Slunfeh, 1056.0 m, 36°10'44.28"E, 35°36'0.81"N, 4.IV.2013 (1 male).

Tartus Province. Tartus Area: Tartus, 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 4.XII.2011 (1 male). Baniyas Area: Al-Qadmus, 919.0 m, 36°9'40.13"E, 35°6'6.53"N, 30.XI.2014 (1 female)/Baniyas, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 25. IX. 2014 (2 males); 4.XI.2014 (1 male)/Kherbet Al-Sansel, 242.0 m, 35°58'20.48"E, 35°10'2.15"N, 15.V.2014 (2 males). Safita Area: Safita, 310.0 m, 36°7'5.14"E, 34°49'1.75"N, 3.XI.2013 (1 female). Draykish Area: Draykish, 470.0 m, 36°8'3.44"E, 34°53'50.65"N, 10.XI.2012 (1 male).

CHOROTYPE. Anatolian (Özdikmenand & Turgut, 2009c).

BIONOMICS. Unknown host plants; biology is still unknown; adults are usually encountered between June–August.

REMARKS. Frequently encountered and widespread in SCR, most of specimens were collected by hand, from trunks and branches of deciduous trees, few samples were collected from wine traps hung at 1.5–2 m above the ground.

Genus *Prionus* Geoffroy, 1762

Type species: *Cerambyx coriarius* Linnaeus, 1758

##### 5. *Prionus komiyai* Lorenc, 1999

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Hannadi, 73.5 m, 35°52'53.5"E, 35°30'10.5"N, 12.XI.2013 (2 males); 7.VIII.2014 (1 male)/Al-Wadi, 470.0 m, 36°3'0.21"E, 35°47'34.64"N, 26.VIII.2014 (2 males)/Serskieh, 55.0 m, 35°55'10.40"E, 35°42'19.84"N, 9.V.2012 (1 male). Jableh Area: Hmimim, 40.0 m, 35°57'1.30"E, 35°22'34.65"N, 14.IX.2012 (2 males)/Ras Al-Ain, 133.0 m, 36°0'38.71"E, 35°19'26.72"N, 18.VII.2014 (2 males)/Siano: 78.0 m, 35°59'39.73"E, 35°22'12.64"N, 9.X.2011 (1 male); 1.XI.2011 (1 male); 7.X.2012 (2 females); 7.XI.2012 (1 male). Qardahah Area: Istamou, 73.0 m, 35°54'8.48"E, 35°29'51.27"N, 16.VII.2014 (1 male)/Ain Al-Arous, 65.0 m, 35°57'15.84"E, 35°26'19.20"N, 18.VIII.2011 (2 females). Haffa Area: Slunfeh, 1056.0 m, 36°10'44.28"E, 35°36'0.81"N, 17.VII.2013 (1 male)/Terjano, 110.0 m, 35°59'15.20"E, 35°31'44.06"N, 29.IX.2012 (2 males); 20.X.2013 (2 females).

Tartus Province. Tartus Area: Tartus, 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 21.XI.2014 (1 male). Baniyas Area: Wadi Al-Saki, 519.0 m, 36°5'26.53"E, 35°6'2.64"N, 7.VII.2014 (1 male). Shayk-Badr Area: Ash Shayk Badr, 491.0 m, 36°4'52.70"E, 34°59'25.23"N, 4.X.2014 (1 male).

CHOROTYPE. The chorotype is SW-Asiatic/Syro-Anatolian (Özdikmenand & Turgut, 2009c).

BIONOMICS. Unknown.

REMARKS. Frequently encountered in SCR. Specimens were usually collected by hand, from trunks and twigs of deciduous trees. Two specimens were collected from banana and beer traps situated in fruit-tree orchards.

Tribe Remphanini Lacordaire, 1868

Genus *Rhaesus* Motschulsky, 1875

Type species: *Rhaesus persicus* Motschulsky, 1875 (= *Prionus serricollis* Motschulsky, 1838)

##### 6. *Rhaesus serricollis* Motschulsky, 1838

EXAMINED MATERIAL. Latakia Province. Latakia Area: Ain Al-Beida, 6.0 m, 35°53'34.2"E, 35°39'28.7"N, 10.IX.2013 (2 females); 7.XI.2014 (2 females)/Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 15. XI. 2013 (2 females); 11.XI.2014 (1 male, 3 females).



Jableh Area: Ain Shkak, 61.0 m, 35°58'54.93"E, 35°23'2.60"N, 7.IX.2012 (1 female)/Besaysin, 29.0 m, 35°57'12.27"E, 35°20'53.43"N, 4.X.2011 (1 male); 16.IX.2013 (2 males); 10.X.2013 (3 males); 11.X.2013 (2 females); 19.IX.2014 (3 males); 16.X.2014 (1 male, 2 females); 29.X.2014 (1 male, 1 female)/Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 5.IX.2013 (2 females); 19.VII.2014 (2 females)/ Ras Al-Ain, 133.0 m, 36° 0'38.71"E, 35°19'26.72"N, 11.X.2013 (2 males, 1 female); 15.XI. 2014 (2 females). Qardahah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 3. X. 2011 (1 male, 1 female); 7.XI.2011 (4 females). Haffa Area: Roimieh, 48.0 m, 35°55'57.70"E, 35°29'44.00"N, 12.XI.2010 (1 female); 16.VII.2013 (1 male); 12.X.2013 (2 females).

Tartus Province. Baniyas Area: Faresh Kaebieh, 301.0 m, 36° 1'18.71"E, 35°11'20.04"N, 6.X.2012 (1 female); 17.V.2014 (1 female)/Wadi Al-Saki, 519.0 m, 36° 5'26.53"E, 35°6'2.64"N, 4.X.2014 (1 female); 13.XI.2014 (1 female); 10.XI.2014 (1 male, 2 females).

CHOROTYPE. Sibero-European+Turano-European-Mediterranean (Özdikmenand & Turgut, 2009c).

BIONOMICS. Polyphagous on deciduous trees: *Fagus*, *Celtis*, *Platanus*, *Quercus*, *Castanea*, *Tilia*, *Juglans*, *Salix*; life cycle usually takes several years; adults are usually encountered between July–September.

REMARKS. Frequently encountered in SCR. Its emergence is often late, with higher numbers being encountered during September. Samples were collected by hand, from trunks and branches of *Juglans* trees, especially during the evening. Some specimens were attracted to light traps situated near walnut trees. Larvae usually fed on the wood of live walnut trees (*Juglans* sp.).

Subfamily Lepturinae Latreille, 1802  
Tribe Lepturini Latreille, 1802

Genus *Stictoleptura* Casey, 1924  
Type species: *Leptura cribripennis* LeConte, 1859

#### 7. *Stictoleptura* (s. str.) *cordigera* Fuessly, 1775

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Bahlouliyah, 224.0 m, 35°57'20.7"E,

35°38'0.6"N, 17.XI.2012 (2 females)/Kirsana, 63.0 m, 35°49'38.4"E, 35°37'4.34"N, 3.IV.2013 (2 males)/Wadi Qandil, 48.0 m, 35°50'28.9"E, 35°43'20.7"N, 2.IX.2012 (1 male, 1 female). Haffa Area: Ghornata, 246.0 m, 35°59'42.00"E, 35°33'35.95"N, 7.VIII.2103 (1 female).

Tartus Province. Tartus Area: Majdaloun Al-Bahr, 60.0 m, 35°56'21.57"E, 34°51'19.22"N, 3.IX.2014 (1 male, 1 female). Baniyas Area: Hreisoun, 14.0 m, 35°57'23.63"E, 35°14'8.88"N, 7.IX.2014 (1 male, 1 female).

CHOROTYPE. Turano-European (Özdikmen, 2008).

BIONOMICS. Polyphagous on deciduous trees (*Castanea*, *Fagus*, *Pistacia*, *Pinus*, *Quercus*); life cycle usually takes 2–3 years; adults are usually encountered between June–July.

REMARKS. Not frequently encountered in SCR. It is usually collected from flowers, especially during spring.

Genus *Vadonia* Mulsant, 1863

Type species: *Leptura unipunctata* Fabricius, 1787

Genus *Neovadonia* Kaszab, 1938: 151

Type species: *Leptura unipunctata* Fabricius, 1787

#### 8. *Vadonia unipunctata syricola* Holzschuh, 1993

EXAMINED MATERIAL. Tartus Province. Baniyas Area: Kirkafiti, 77.0 m, 35°56'55.35"E, 35° 4'32.53"N, 16.X.2014 (1 female).

CHOROTYPE. Unknown. Distribution: Lebanon, and Syria.

BIONOMICS. Biology unknown, probably similar to the nominal form; adults are usually encountered between May–August.

REMARKS. Rather a rare species in SCR; the specimen was collected by hand, from flowers of *Euphorbia* plants. The chorotype is unknown, but the pattern of distribution of this subspecies suggests endemism to Syria.

Subfamily Spondylinae Audinet-Serville, 1832  
Tribe Asemmini J. Thomson, 1861

Genus *Arhopalus* Audinet-Serville, 1834

Type species: *Cerambyx rusticus* Linnaeus, 1758

### 9. *Arhopalus ferus* Mulsant, 1839

EXAMINED MATERIAL. Latakia Province. Latakia Area: Zighrin, 44.0 m, 35°52'35.97"E, 35°42'55.45"N, 5.VI.2011 (3 females); 17.VII.2013 (1 male, 1 female). Qardahah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 29.VI.2013 (1 female); 19.IX.2013 (1 male, 1 female); 20.X.2013 (1 male, 2 females).

Tartus Province. Baniyas Area: Zoubbeh, 407.0 m, 35°58'45.50"E, 35°7'14.92"N, 19.XI.2014 (1 female); 23.VII.2014 (2 females).

CHOROTYPE. Sibero-European and the Turano-European-Mediterranean (Özdikmen & Turgut, 2006).

BIONOMICS. Monophagous on pine (*Pinus* spp.) but might rarely feed on spruce (*Picea*); life cycle usually takes 2–3 years; adults are usually encountered between May–August.

REMARKS. Frequently encountered in SCR, especially near pine (*Pinus* sp.) forests, and usually attracted to light; few specimens were collected by sweeping herbaceous plants.

### 10. *Arhopalus syriacus* Reitter, 1895

EXAMINED MATERIAL. Latakia Province. Latakia Area: Bdamioun, 66.0 m, 35°54'38.57"E, 35°35'33.84"N, 3.X.2012 (3 males)/ Latakia, 20.0 m, 35°46'51.7"E, 35°31'47.1"N, 1.XII.2014 (1 female)/Zighrin, 44.0 m, 35°52'35.97"E, 35°42'55.45"N, 11.IX.2014 (2 females); 17.X.2014 (2 females). Jableh Area: Al-Kabou, 20.0 m, 35°53'20.65"E, 35°27'43.20"N, 9.VIII.2013 (1 female)/Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 20.VIII.2014 (1 male, 1 female). Qardahah Area: Dibash, 447.0 m, 36°4'13.50"E, 35°30'50.08"N, 27.IX.2011 (2 males); 20.IX.2013 (2 females). Tartus Province. Baniyas Area: Srijis, 585.0 m, 36°10'59.04"E, 34°55'55.51"N, 21.VIII.2014 (2 males)/Wadi Al-Saki, 519.0 m, 36°5'26.53"E, 35°6'2.64"N, 12.IX.2013 (2 males).

CHOROTYPE. S-European+E-Mediterranean/Palaestino-Cyprioto-Taurian (Özdikmen and Turgut, 2006).

BIONOMICS. Usually monophagous on pine (e.g. *Pinus pinaster*, *P. salzmanni*, *P. laricio*, *P. halepensis*); life cycle usually takes 2–4 years; adults are usually encountered between June–September.

REMARKS. Closely related to *Arhopalus ferus* Mulsant, 1839 and usually accompanies it.

Subfamily Cerambycinae Latreille, 1802

Tribe Achrysonini Lacordaire, 1868

Genus *Icosium* P.H. Lucas, 1854

Type species: *Icosium tomentosum* P.H. Lucas, 1854

### 11. *Icosium tomentosum atticum* Ganglbauer, 1882

EXAMINED MATERIAL. Latakia Province. Latakia Area: Bisnada, 21 m, 35°48'14.97"E, 35°32'52.65"N, 14.VI.2012 (2 females).

Tartus Province. Baniyas Area: Baniyas, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 19.XI.2014 (2 males, 1 female). Shayk-Badr Area: Al-Msherfeh, 270.0 m, 35°59'57.49"E, 35°9'40.74"N, 3.VI.2012 (2 females)/Qamsyiah, 398.0 m, 35°59'31.46"E, 35°3'11.38"N, 22.X.2013 (2 males).

CHOROTYPE. Mediterranean (Özdikmen, 2008).

BIONOMICS. Oligophagous on various Cupressaceae: *Cupressus sempervirens* L., *C. propinqua*, *Tetraclinis articulata* (Vahl) Mast., *Juniperus oxycedrus* L., *Thuja*, *Callitris*); life cycle usually takes 2–3 years; adults are usually encountered between June–August.

REMARKS. This is the first record of this species in Syria. Its activity is usually nocturnal; some specimens were collected from light traps, especially near forests, other specimens were collected by hand, from branches of some deciduous trees.

Tribe Callichromatini Swainson et Shuckard, 1840

Genus *Aromia* Audinet-Serville, 1834

Type species: *Cerambyx moschatus* Linnaeus, 1758  
*Terambus* Gistel, 1848b [unnecessary substitute name]

### 12. *Aromia moschata ambrosiaca* Steven, 1809

*Aromia melancholica* Reitter, 1895

*Aromia notaticollis* Pic, 1928

*Aromia rosara* P.H. Lucas, 1847

*Aromia rosara* A. Costa, 1855 (*Cerambyx*)

EXAMINED MATERIAL. Latakia Province. Latakia Area: Bdamioun, 66.0 m, 35°54'38.57"E, 35°35'33.84"N, 28.XI.2011 (1 male). Jableh Area: Qutaolabyah, 215 m, 36°1'8.98"E, 35°17'13.14"N, 24.XI.2012 (3 males).



CHOROTYPE. Palearctic (Özdikmen, 2014).

BIONOMICS. Ecologically, it is strictly associated with willow (*Salix* spp.), it rarely feeds on other deciduous trees: *Populus nigra* L., *Sorbus*, *Alnus*, *Acer*; life cycle usually takes 3 or more years; adults are usually encountered between May–September.

REMARKS. Very attractive to collectors, but rather rare in SCR. Specimens were collected by hand from tree trunks of willow trees (*Salix* sp.). It is known to emit an aromatic scent that smells like attar (Linsley, 1959).

Tribe Callidiini Kirby, 1837

Genus *Phymatodes* Mulsant, 1839

Type species: *Cerambyx variabilis* Linnaeus, 1760 (= *Cerambyx testaceus* Linnaeus, 1758)

Subgenus *Paraphymatodes* Plavilstshikov, 1934

Type species: *Callidium fasciatum* Villers, 1789

13. ***Phymatodes (Paraphymatodes) fasciatus*** Villers, 1789

*Paraphymatodes unifasciatus* Olivier, 1790 (*Callidium*)

*Paraphymatodes unifasciatus* Rossi, 1790 (*Callidium*)

EXAMINED MATERIAL. Latakia Province, Latakia Area: Zakizkanieh, 54.0 m, 35°48'29.85"E, 35°31'47.30"N, 4.V.2014 (1 male).

CHOROTYPE. Unknown. Distribution: Europe (Austria, Bosnia-Herzegovina, Bulgaria, Croatia, Czech Republic, France, Greece, Hungary, Italy, Latvia, Macedonia, Moldavia, Poland, Romania, Slovakia, Spain, Slovenia, Switzerland, Ukraine, Serbia, and Montenegro), Asia (Cyprus, Limassol, Troodos mountains, Kato Platres, Sama leg.; Palestine, Tel Dan, Kravchenko leg.; Turkey, Antalya, Perge and İçel, Çamliyayla, Sama's collection). New record for Cyprus, Turkey and Palestine.

BIONOMICS. Monophagous on grapevine *Vitis vinifera* L., but it is also reported on other deciduous trees: e.g. *Parthenocissus quinquefolia* (L.) Planch., *Clematis*, *Populus alba* L., *Quercus robur* L., *Salix alba* L.; life cycle usually takes one year; adults are usually encountered between May–June.

REMARKS. This is the first record of this species in Syria. It is very rare in SCR; the specimen was encountered on a wall near a light source.

Tribe Cerambycini Latreille, 1802

Genus *Cerambyx* Linnaeus, 1758

Type species: *Cerambyx cerdo* Linnaeus, 1758

14. ***Cerambyx cerdo*** Linnaeus, 1758

*Cerambyx heros* Scopoli, 1763

EXAMINED MATERIAL. Latakia Province, Latakia Area: Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 14.XI.2014 (2 males). Jableh Area: Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 16.VIII.2014 (1 male)/ Ras Al-Ain: 133.0 m, 36°0'38.71"E, 35°19'26.72"N, 5.IV.2014 (2 males, 1 female).

Tartus Province. Tartus Area: Zarkat, 100.0 m, 35°57'14.82"E, 34°50'31.49"N, 21.X.2014 (1 male). Baniyas Area: Al-Qadmus, 919.0 m, 36°9'40.13"E, 35°6'6.53"N, 2.XI.2014 (1 female). Safita Area: Safita, 310.0 m, 36°7'5.14"E, 34°49'1.75"N, 16.VI.2012 (2 males); 17.V.2014 (1 female).

CHOROTYPE. Turano-Europeo-Mediterranean (Özdikmen and Turgut, 2009b).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Quercus*, *Juglans*, *Ceratonia*), it is reported probably by occasional adaptation for other broadleaf trees (*Fraxinus*, *Castanea*, *Ulmus*); life cycle usually takes 3 years at least; adults are usually encountered between May–August.

REMARKS. Widely spread in SCR. The subspecies *C. cerdo acuminatus* Motschulsky, 1853 is recorded in countries of the Middle East (including Syria), but it is rather a doubtful subspecies. We prefer not to indicate the subspecies before a study on the whole genus *Cerambyx* from the East Mediterranean. Specimens were collected by hand from trunks and branches of deciduous trees (usually from orchards). The flight of this species is rather slow.

15. ***Cerambyx dux*** Faldermann, 1837

EXAMINED MATERIAL. Latakia Province, Latakia Area: Ain Al-Laban, 68.0 m, 35°53'47.99"E, 35°35'36.83"N, 8.XI.2013 (1 male, 1 female)/Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 14.XI.2012 (2 males, 2 females); 25.X.2013 (1 male); 3.IX.2014 (3 males)/Al-Qanjara, 72.45 m, 35°52'25.1"E, 35°30'43.4"N, 22.X.2013 (2 females)/Al-Safkoun, 206.0 m, 35°59'17.57"E,



35°38'57.24"N, 15.X.2011 (2 females)/Al-Shil-fatiyah, 45.0 m, 35°53'57.6"E, 35°32'21.5"N, 20.X.2012 (1 male, 1 female)/Balloran, 193.0 m, 35°53'35.30"E, 35°46'40.52"N, 3.VIII.2011 (1 female); 11.X.2012 (1 male)/Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 14.IV.2012 (2 males); 24.IV.2012 (3 males); 27.V.2014 (2 males)/Bouka, 62.0 m, 35°48'32.26"E, 35°32'17.80"N, 16.XI.2013 (1 male); 7.XI.2013 (3 males)/Dem-sarkho, 17.0 m, 35°46'36.8"E, 35°33'12.6"N, 25.IX.2012 (2 males); 16.X.2012 (1 male)/Dibba, 32.0 m, 35°54'36.18"E, 35°32'18.46"N, 1.V.2013 (1 female); 26.IX.2013 (2 males); 7.IV.2014 (2 males)/Jbariun, 15.0 m, 35°53'20.43"E, 35°34'22.27"N, 14.IX.2014 (3 females)/Khreibeh, 816.0 m, 36°6'11.91"E, 35°17'26.83"N, 26.X.2014 (2 males)/Klouf: 120 m, 35°51'45.74"E, 35°38'33.34"N, 17.IV.2014 (1 male, 1 female)/Latakia, 20.0 m, 35°46'51.7"E, 35°31'47.1"N, 11.XI.2011 (1 male)/Rodo, 38.0 m, 35°51'5.65"E, 35°33'40.16"N, 16.IX.2013 (2 males)/Serskieh, 55.0 m, 35°55'10.40"E, 35°42'19.84"N, 16.V.2013 (1 male, 1 female)/Sin-jwan, 81.0 m, 35°49'28.7"E, 35°32'46.9"N, 14.VIII.2012 (1 male)/Tisheen University Campus, 31.0 m, 35°48'25.7"E, 35°31'29.0"N, 3.IV.2013 (2 males)/Zeitounah, 468 m, 36°8'37.49"E, 35°48'27.15"N, 13.IX.2014 (2 females). Jableh Area: Ain Al-Dilb, 440.0 m, 36°3'14.17"E, 35°13'40.87"N, 6.IV.2014 (1 male, 2 females)/Al-Eidia, 40 m, 35°58'33.97"E, 35°17'9.67"N, 30.IX.2014 (3 males, 1 female)/Al-Kloun, 8.0 m, 35°57'3.08"E, 35°15'2.05"N, 29.V.2013 (3 males); 11.X.2014 (1 male)/Al-Louzeh, 24.0 m, 35°56'27.99"E, 34°48'29.73"N, 11.X.2011 (1 male); 13.X.2011 (2 males, 1 female)/Babdah, 505.0 m, 36°3'15.47"E, 35°14'22.16"N, 15.X.2012 (2 males)/Besaysin, 29 m, 35°57'12.27"E, 35°20'53.43"N, 17.VIII.2011 (1 male); 3.X.2012 (2 females); 7.IX.2014 (2 males); 13.IX.2014 (2 females); 16.IX.2014 (1 male, 2 females)/Btimazah Mountain, 1280.0 m, 36°13'57.59"E, 35°13'11.66"N, 1.XI.2014 (3 males, 2 females)/Burjan, 48.0 m, 35°58'44.66"E, 35°17'31.22"N, 11.X.2011 (2 females); 10.XI.2011 (1 male)/Bustan Al-Basha, 33.0 m, 35°56'3.35"E, 35°25'26.46"N, 4.V.2013 (2 males); 7.V.2013 (1 female)/Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 14.XI.2012 (1 female)/Kfar Dbil, 110.0 m, 36°0'38.76"E, 35°22'48.90"N, 1.XI.2013 (4 males)/Qutaolabyah, 215.0 m, 36°1'8.98"E, 35°17'13.14"N, 6.IV.2014 (1 male, 1 female); 18.V.2014 (1 male)/

Rahbieh, 8.0 m, 35°57'22.07"E, 35°15'30.94"N, 6.V.2013 (1 male, 1 female)/Ras Al-Ain, 133.0 m, 36°0'38.71"E, 35°19'26.72"N, 22.VII.2012 (2 males); 20.IX.2013 (2 females)/Rmelieh, 14.0 m, 35°55'26.93"E, 35°22'54.71"N, 17.VIII.2014 (1 male, 1 female)/Sarabion, 362.0 m, 36°1'8.00"E, 35°14'12.12"N, 19.IX.2012 (1 male, 2 female); 12.IX.2013 (1 male, 1 female); 21.X.2013 (2 females)/Zama, 274.0 m, 36°4'30.32"E, 35°20'48.18"N, 21.XI.2012 (2 males). Qardahah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 23.XI.2011 (1 male); 1.XI.2012 (1 male)/Istamou, 73.0 m, 35°54'8.48"E, 35°29'51.27"N, 15.X.2014 (2 males)/Qulmakho, 160.0 m, 35°59'19.85"E, 35°27'46.22"N, 3.XI.2011 (1 male). Haffa Area: Al-Haffah, 272.0 m, 36°1'59.38"E, 35°35'41.57"N, 8.VIII.2011 (1 male, 1 female)/As-Samia, 197.0 m, 35°59'20.56"E, 35°33'16.80"N, 15.IX.2014 (2 females)/Marj Khokhah, 834.0 m, 36°9'14.37"E, 35°41'29.50"N, 23.X.2013 (2 males)/Mzeraah, 515.0 m, 36°4'19.18"E, 35°31'59.55"N, 25.IX.2011 (2 females); 16.V.2012 (2 males); 13.IX.2014 (2 males); 2.XI.2014 (3 males, 2 females)/Shiek Hussamo, 631.0 m, 36°5'46.01"E, 35°35'45.99"N, 3.X.2012 (2 females)/Talla, 178.0 m, 35°58'42.70"E, 35°38'14.99"N, 10.X.2012 (2 males).

Tartus Province. Tartus Area: Al-Karimeh, 185.0 m, 36°2'31.34"E, 35°21'17.62"N, 7.V.2013 (2 males, 1 female); 3.V.2014 (2 males)/As-Sifsafah, 130.0 m, 36°2'55.04"E, 34°43'57.80"N, 18.V.2013 (1 male)/Beit Alian: 56.0 m, 35°56'17.91"E, 34°51'13.93"N, 26.X.2014 (1 male, 3 females)/Tartus, 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 15.X.2011 (1 male); 20.X.2011 (1 male)/Kherbet Al-Mezeh, 154.0 m, 36°1'43.98"E, 34°48'6.31"N, 23.X.2014 (2 males)/Marqueh, 55.0 m, 35°55'5.27"E, 35°1'56.45"N, 20.IX.2012 (1 male)/Saya, 216.0 m, 35°56'55.30"E, 35°2'46.23"N, 8.IX.2013 (2 males); 17.VIII.2014 (1 male, 2 females); 3.X.2014 (3 males, 1 female). Baniyas Area: Al-Qadmus, 919.0 m, 36°9'40.13"E, 35°6'6.53"N, 1.V.2013 (2 males)/Al-Roudah, 150.0 m, 35°54'53.46"E, 35°4'2.91"N, 13.IX.2013 (2 males, 1 female); 16.VIII.2014 (1 male, 2 females)/Balloutieh, 460.0 m, 36°2'40.17"E, 35°11'2.14"N, 5.X.2011 (1 female)/Baniyas, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 15.X.2012 (2 males)/Bustan Al-Hamam, 337.0 m, 36°2'0.50"E, 35°12'25.81"N, 7.IV.2013 (1 male); 16.VII.2014 (1 male, 1 female)/Deir Al-Bishl, 101.0 m, 35°58'56.27"E, 35°11'48.97"N, 16.V.2013



(2 females)/Hreisoun, 14.0 m, 35°57'23.63"E, 35°14'8.88"N, 16.IX.2014 (2 males, 1 female)/Hamam Wasel, 642.0 m, 35°59'42.00"E, 35°33'35.95"N, 9.IX.2013 (2 males)/Isqublh, 690.0 m, 36°3'39.70"E, 35°9'54.14"N, 6.IV.2013 (1 male)/Kherbet Al-Sansel, 242.0 m, 35°58'20.48"E, 35°10'2.15"N, 4.IV.2013 (1 male, 2 females); 3.V.2013; 15.V.2013 (1 male, 1 female)/Khirbit Al-Sindiana, 851 m, 36°11'40.29"E, 35°13'31.47"N, 17.VI.2014 (1 male, 1 female)/Mourid, 120.0 m, 35°56'19.04"E, 35°6'19.51"N, 17.IV.2014 (1 male)/Taenita, 471.0 m, 36°3'42.95"E, 35°6'42.87"N, 19.X.2011 (1 male, 1 female)/Zillo, 235.0 m, 36°1'33.56"E, 35°12'1.37"N, 8.VIII.2012 (2 females). Safita Area: Safita, 310.0 m, 36°7'5.14"E, 34°49'1.75"N, 20.X.2011 (1 males); 7.X.2012 (2 males); 17.X.2012 (2 females); 22.XI.2012 (2 males); 25.X.2012 (1 males); 17.X.2013 (1 male); 12.X.2014 (3 female); 9.IX.2014 (3 males); 29.X.2014 (1 male, 1 female). Shayk-Badr Area: Blawzeh, 462.0 m, 36°1'5.23"E, 35°8'59.40"N, 23.VII. 2011 (1 male, 1 female)/Kafroun, 675.0 m, 36°14'18.96"E, 34°51'58.57"N, 2.X.2011 (1 female)/Ash Shayk Badr, 491.0 m, 36°4'52.70"E, 34°59'25.23"N, 4. VIII. 2012 (3 males); 22.X.2013 (2 males, 1 female); 23.XI.2013 (1 male, 1 female); 7.IX.2014 (2 males)/Kfarieh, 368 m, 36°4'20.62"E, 34°58'17.16"N, 15.X.2012 (2 females). Draykish Area: Draykish, 470.0 m, 36°8'3.44"E, 34°53'50.65"N, 6.V.2011 (1 male); 16.VI.2012 (2 males); 16.V.2013 (2 males); 5.VIII.2013 (2 males); 1.X.2014 (3 males, 2 females); 3.X.2014 (1 female).

CHOROTYPE. Turano-Mediterranean/Turano-Balkan (Özdikmenand & Turgut, 2009b).

BIONOMICS. Polyphagous on fruit and ornamental trees, and sometimes bushes: e.g. *Prunus*, *Elaeagnus*, *Crataegus*, *Pyracantha crenatoserrata* (Hance) Rehder; life cycle usually takes 3–4 years; adults are usually encountered between May–July.

REMARKS. Exteremely widespread in SCR, and usually encountered everywhere, especially in *Prunus* sp. orchards. Collection was usually conducted by hand, or by entomological nets. Few samples were obtained from ripe banana and sweet wine traps. This species is considered as a major pest to *Prunus* sp. orchards, inflicting heavy damages to fruit orchards. It is also considered as a notorious insect, and is often killed by farmers whenever and wherever spotted.

# 16. *Cerambyx nodulosus* Germar, 1817

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 25.IX.2014 (1 male)/Al-Shilfatiyah, 45.0 m, 35°53'57.6"E, 35°32'21.5"N, 20.X.2012 (1 male, 2 females)/Al-Tarquia, 81.0 m, 35°57'12.55"E, 35°39'51.55"N, 31.VII.2013 (1 male, 2 females)/Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 29.XI.2014 (1 male)/Kirsana, 63.0 m, 35°49'38.4"E, 35°37'4.34"N, 16.IX.2014 (2 males); 2.X.2014 (1 male). Jableh Area: Bustan Al-Basha, 33.0 m, 35°56'3.35"E, 35°25'26.46"N, 8.IX.2014 (1 male); 15.IX.2014 (1 male)/Dwaer Baabda, 606.0 m, 36°2'41.58"E, 35°14'54.99"N, 7.XI.2014 (1 male)/Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 26.X.2011 (1 male)/Qutaolabyah, 215.0 m, 36°1'8.98"E, 35°17'13.14"N, 30.X.2012 (2 males, 1 female); 7.X.2014 (2 males). Qardahah Area: Deir Hanna, 221.0 m, 36°2'2.82"E, 35°25'47.94"N, 22.X.2012 (2 males). Haffa Area: Al-Haffah, 272.0 m, 36°1'59.38"E, 35°35'41.57"N, 15. IX. 2014 (2 males).

Tartus Province. Tartus Area: Yahmour, 65.0 m, 35°57'44.44"E, 34°48'57.66"N, 6.VI.2012 (2 males). Baniyas Area: Annaza, 553.0 m, 36°3'58.56"E, 35°11'47.31"N, 3.V.2013 (1 male)/Kherbet Al-Sansel, 242.0 m, 35°58'20.48"E, 35°10'2.15"N, 7.V.2013 (2 males); 16.IX.2014 (2 males). Safita Area: Safita, 310.0 m, 36°7'5.14"E, 34°49'1.75"N, 16.VI.2012 (2 males, 1 female); 25.VII.2013 (2 males). Shayk-Badr Area: Ash Shayk Badr, 491.0 m, 36°4'52.70"E, 34°59'25.23"N, 23.XI.2014 (1 male).

CHOROTYPE. East-Mediterranean.

BIONOMICS. Polyphagous on deciduous trees: *Prunus*, *Pyrus*, *Malus*, *Crataegus*, *Acer*; life cycle usually takes 3–4 years; adults are usually encountered between May–July.

REMARKS. Usually associated with *Cerambyx dux*, but much less spread, and less frequently encountered. Specimens were collected from stone fruit orchards (*Prunus* sp.) usually by hand, very few were attracted to wine traps.

# 17. *Cerambyx welensii* Küster, 1845

EXAMINED MATERIAL. Latakia Province. Latakia Area: Latakia, 20.0 m, 35°46'51.7"E, 35°31'47.1"N,

12.X.2011 (1 male)/Qismin, 191.0 m, 35°54'18.6"E, 35°38'1.2"N, 6.X.2013 (1 female). Jableh Area: Siano, 78.0 m, 35°59'39.73"E, 35°22'12.64"N, 23.VIII.2014 (1 female). Qardahah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 3.X.2012 (2 females); 23.IX.2013 (1 male); 13.IX.2014 (1 female). Haffa Area: Mzeraah, 515.0 m, 36°4'19.18"E, 35°31'59.55"N, 13.XI.2014 (1 male).

Tartus Province. Tartus Area: Tartus: 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 23.X.2013 (2 males)/Yahmour, 65.0 m, 35°57'44.44"E, 34°48'57.66"N, 16.V.2014 (1 male). Baniyas Area: Al-Qadmus, 919.0 m, 36°9'40.13"E, 35°6'6.53"N, 17.VIII.2012 (1 female); 16.IX.2014 (2 males); 30.XI.2014 (2 males). Safita Area: Safita, 310.0 m, 36°7'5.14"E, 34°49'1.75"N, 16.IX.2014 (1 female); 8.X.2014 (1 male).

CHOROTYPE. S-European (Özdikmenand & Turgut, 2009b).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Quercus*, *Platanus*, *Ceratonia*), but mostly on *Quercus ilex*, *Q. ithaburensis*, and *Q. calliprinos*; life cycle usually takes three years at least; adults are usually encountered between June–July.

REMARKS. Frequently encountered in SCR. The subspecies *C. welensii centurio* Czwalina, 1891 is recorded in the countries of the Middle East (including Syria), but it is rather a doubtful subspecies, since it is little different from European subspecies; accordingly, we prefer not indicate the subspecies before a study on the whole genus *Cerambyx* from the East Mediterranean.

Tribe Certallini Fairmaire, 1864

Genus *Certallum* Dejean, 1821

Type species: *Saperda ruficollis* Fabricius, 1781 (= *Cerambyx ebulinus* Linnaeus, 1767)

18. *Certallum ebulinum* Linnaeus, 1767

EXAMINED MATERIAL. Latakia Province. Jableh Area: Siano, 78.0 m, 35°59'39.73"E, 35°22'12.64"N, 13.VIII.2013 (1 male).

Tartus Province. Shayk-Badr Area: Al-Msh-erfeh, 270.0 m, 35°59'57.49"E, 35°9'40.74"N, 16.IX.2012 (1 female).

CHOROTYPE. Turano-European-Mediterranean (Özdikmen, 2008).

BIONOMICS. Polyphagous on herbaceous plants (e.g. Brassicaceae), and also recorded on *Raphanus*, *Raphanistrum*, *Raphanistrum arvense* (All.) Mérat; life cycle takes usually two years; adults are usually encountered between March–July.

REMARKS. It is rather a rare species in SCR; specimens were collected by hand from flowers of Astreraceae plants.

Tribe Clytini Mulsant, 1839

Genus *Chlorophorus* Chevrolat, 1863

Type species: *Callidium annulare* Fabricius, 1787

19. *Chlorophorus varius damascenus* Chevrolat, 1854

EXAMINED MATERIAL. Latakia Province. Latakia Area: Kirsana, 63.0 m, 35°49'38.4"E, 35°37'4.34"N, 6.X.2013 (1 male, 1 female).

CHOROTYPE. Palearctic (Özdikmen & Tugrut, 2009e).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Vitis*, *Acer*, *Quercus*, *Populus*, *Malus*, *Crataegus*, *Junglans*, *Robinia*, *Elaeagnus*, *Ficus*, *Sesbania*, *Prunus*, *Pyrus*, *Morus*, *Castanea*, *Ulmus*, *Alnus*, *Fraxinus*, *Pistacia*, *Paliurus*, *Spartium*, *Cercis siliquastrum* L., *Pistacia atlantica* Desf.); life cycle usually takes 2–3 years; adults are usually encountered between June–September.

REMARKS. It is a rare species in SCR. The specimen was collected by hand from the flowers of an Apiaceae plant.

20. *Chlorophorus sartor* O.F. Müller, 1766

EXAMINED MATERIAL. Tartus Province. Baniyas Area: Kirkafiti, 77.0 m, 35°56'55.35"E, 35°4'32.53"N, 14. XI. 2014 (1 male).

CHOROTYPE. Turano-European (Özdikmen & Turgut, 2009e).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Paliurus*, *Quercus*, *Ulmus*, *Crataegus*, *Elaeagnus*, *Castanea*, *Robinia*, *Ficus*, *Cytisus*, *Pistacia*, *Ceratonia*, *Salix*, *Fagus*, *Ostrya*, *Gleditsia*); life cycle usually takes two years; adults are usually encountered between May–August.

REMARKS. Rare species in SCR, the specimen was collected from the flowers of an Asteraceae plant.



Genus *Clytus* Laicharting, 1784

Type species: *Leptura arietis* Linnaeus, 1758

21. *Clytus rhamni* Germar, 1817

*Clytus innormalis* Pic, 1927

*Clytus paliuri* Depoli, 1940

EXAMINED MATERIAL. Tartus Province. Baniyas Area: Dahr Safra, 226.0 m, 35°55'17.81"E, 35°4'42.10"N, 10.XI.2014 (1 male).

CHOROTYPE. European (Özdikmen & Turgut, 2009f).

BIONOMICS. Polyphagous on deciduous trees; life cycle usually takes two years; adults are usually encountered between May–August.

REMARKS. It is a quite rare species in SCR. The pattern of its distribution suggests European-Anatolian/Mediterranean chorotype. The specimen was collected by the hand from the flowers of an Asteraceae plant.

Genus *Plagionotus* Mulsant, 1842

Type species: *Leptura detrita* Linnaeus, 1758

22. *Plagionotus bobelayei* Brullé, 1832

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 13.XI.2014 (1 male)/Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 7.VI.2013 (2 males); 8.VIII.2013 (1 male, 1 female). Jableh Area: Qutaolabyah, 215.0 m, 36°1'8.98"E, 35°17'13.14"N, 20. XI. 2012 (2 males, 1 female)/Siano, 78.0 m, 35°59'39.73"E, 35°22'12.64"N, 28.IV.2014 (1 male).

Tartus Province. Baniyas Area: Baniyas, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 13.V.2014 (1 male, 1 female)/Mourid, 120.0 m, 35°56'19.04"E, 35°6'19.51"N, 7.IV.2014 (1 female).

CHOROTYPE. Turano-European/Turano-Sarmato-Pannonian (Özdikmen & Turgut, 2009d).

BIONOMICS. Ecologically associated with Malvaceae (e.g. *Alcea*, *Malva*), larvae usually feed on roots; life cycle usually takes one year; adults are usually encountered between May–July.

REMARKS. It is usually encountered, especially during spring (e.g. April and May). Specimens were

collected by hand from the flowers of some Asteraceae plants, or by sweeping some Malvaceae plants.

Genus *Xylotrechus* Chevrolat, 1860

Type species: *Clytus sartorii* Chevrolat, 1860

23. *Xylotrechus* (s. str.) *stebbingi* Gahan, 1906

EXAMINED MATERIAL. Tartus Province. Baniyas Area: Kirkafti, 77.0 m, 35°56'55.35"E, 35°4'32.53"N, 3.X.2014 (1 male).

CHOROTYPE. Mediterraneo-Sindian+Oriental (Özdikmen & Tezcan, 2011).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Alnus*, *Celtis australis*, *Ceratonia siliqua*, *Ficus*, *F. carica*, *Juglans*, *Koelreuteria paniculata* Laxm., *Morus alba*, *Populus*, *Ulmus*); life cycle usually takes two years; adults are usually encountered between May–November.

REMARKS. This is the first record of this species in Syria. It is rather a rare species in SCR; the specimen emerged from a dead branch of a walnut tree (*Juglans* sp.).

Tribe Hesperophanini Mulsant, 1839

Genus *Hesperophanes* Dejean, 1835

Type species: *Callidium sericeum* Fabricius, 1787

24. *Hesperophanes sericeus* Fabricius, 1787

EXAMINED MATERIAL. Latakia Province. Latakia Area: Wadi Qandil, 48.0 m, 35°50'28.9"E, 35°43'20.7"N, 29.X.2011 (1 male). Jableh Area: Bitshah, 920.0 m, 36°5'59.67"E, 35°14'48.47"N, 27. IX. 2012 (2 males); 25.X.2013 (1 female). Haffa Area: Al-Haffah, 272.0 m, 36°1'59.38"E, 35°35'41.57"N, 25.XI.2011 (1 male, 1 female); 15.XI.2012 (2 males)/Mzer3ah, 515.0 m, 36°4'19.18"E, 35°31'59.55"N, 16.X.2011 (4 males); 27.X.2011 (2 males).

Tartus Province. Shayk-Badr Area: Al-Msherfeh, 270.0 m, 35°59'57.49"E, 35°9'40.74"N, 27.X.2011 (1 male, 1 female).

CHOROTYPE. Mediterranean (Özdikmen, 2008).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Juglans*, *Ficus*, *Pistacia*, *Vitis*, *Olea*, *Platanus*, *Quercus*, *Halocnemum*); life cycle usually takes 2–3 years; adults are usually encountered between June–September.

REMARKS. This is the first record of this species in Syria; it is distributed in almost all SCR. It is usually encountered at night (nocturnal). Specimens were collected by hand from branches of deciduous trees usually at dusk, and some samples were attracted to light traps situated near forest sites.

Genus *Stromatium* Audinet-Serville, 1834

Type species: *Callidium barbatum* Fabricius, 1775

## 25. *Stromatium unicolor* Olivier, 1795

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 27.XI.2013 (2 males); 12.X.2014 (2 males)/Al-Karkit, 135.0 m, 35°58'48.62"E, 35°37'20.13"N, 13.VII.2013 (2 males, 3 females)/Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 3.VIII.2012 (1 male); 28.VII.2013 (2 males); 19.IX.2013 (1 male); 14.X.2014 (2 males)/Latakia, 20.0 m, 35°46'51.7"E, 35°31'47.1"N, 3.X.2014 (1 male)/Kamlieh, 242.0 m, 35°54'6.06"E, 35°40'5.31"N, 15.VII.2013 (1 male, 1 female)/Ras Al-Basit, 21.0 m, 35°50'21.33"E, 35°50'47.86"N, 3.IV.2013 (2 males)/Sett Markho, 134.0 m, 35°51'9.29"E, 35°35'8.83"N, 20.X.2011 (2 male). Jableh Area: Ain Shkak, 61.0 m, 35°58'54.93"E, 35°23'2.60"N, 2.XI.2013 (1 male, 1 female)/Al-Baraem, 358.0 m, 36°1'26.30"E, 35°16'19.27"N, 21.VIII.2010 (2 females)/Al-Hwaiz, 107.0 m, 36°0'27.93"E, 35°20'20.17"N, 24.X.2013 (2 males)/Besaysin, 29.0 m, 35°57'12.27"E, 35°20'53.43"N, 10.IX.2012 (3 males); 16.IX.2013 (2 males)/Beit Yashut, 1145.0 m, 36°11'42.93"E, 35°16'41.29"N, 5.XI.2014 (1 male)/Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 20.XI.2013 (1 male)/Ras Al-Ain, 133.0 m, 36°0'38.71"E, 35°19'26.72"N, 6.X.2013 (1 male)/Wadi Al-Kalem, 35.0 m, 35°58'6.69"E, 35°15'3.17"N, 10.X.2012 (2 males). Qardahah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 29.XI.2011 (2 females). Haffa Area: Al-Haffah, 272.0 m, 36°1'59.38"E, 35°35'41.57"N, 15.IX.2011 (1 male); 14.IV.2014 (2 males)/Mzeraah, 515.0 m, 36°4'19.18"E, 35°31'59.55"N, 30.V.2013 (1 male); 7.XI.2014 (1 male, 1 female)/Sirna: 710.0 m, 36°6'24.03"E, 35°36'59.04"N, 12.VIII.2011 (1 male, 1 female); 17.VIII.2011 (1 male)/Slunfeh, 1056.0 m, 36°10'44.28"E, 35°36'0.81"N, 18.V.2011 (2 males).

Tartus Province. Tartus Area: Tartus, 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 13.VII.2012 (1 male); 13.IX.2013 (2 males, 2 females). Baniyas Area: Al-Klough, 8.0 m, 35°57'3.08"E, 35°15'2.05"N, 18.VI.2013 (2 males)/Al-Mawsheh, 254.0 m, 35°58'40.36"E, 35°3'51.05"N, 15.VIII.2011 (2 males)/Baniyas, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 15.VIII.2013 (2 males, 2 females)/Isqublh, 690.0 m, 36°3'39.70"E, 35°9'54.14"N, 20.XI.2013 (1 female)/Kherbet Al-Sansel, 242.0 m, 35°58'20.48"E, 35°10'2.15"N, 7.IV.2013 (3 males, 1 female)/Wadi Al-Saki: 519.0 m, 36°5'26.53"E, 35°6'2.64"N, 3.XI.2014 (1 male, 1 female); 3.X.2014 (1 female). Shayk-Badr Area: Ash Shayk Badr, 491.0 m, 36°4'52.70"E, 34°59'25.23"N, 19.IX.2014 (1 male). Draykish Area: Himmin, 365.0 m, 36°2'35.84"E, 34°54'11.12"N, 10.VIII.2013 (1 female).

CHOROTYPE. Subcosmopolitan/Nearctic+Neotropic+Mediterranean+Centralasiatic (Özdikmen, 2008b).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Quercus*, *Celtis*, *Ulmus*, *Cytisus*, *Pistacia*, *Junglans*, *Fagus*, *Morus*, *Cassia*, *Ficus*, *Corylus*, *Platanus*, *Tarix*, *Robinia*, *Prunus*, *Tilia*, *Carpinus*, *Castanea*, *Salix*, *Alnus*, *Citrus*, *Eucalyptus*, *Pinus*, *Cupressus*); life cycle usually takes 2–4 years; adults are usually encountered between May–August.

REMARKS. Widely spread across SCR, and very frequently encountered. Some specimens were collected by hand from trunks or branches of deciduous trees, other specimens were attracted to light.

Genus *Trichoferus* Wollaston, 1854

Type species: *Trichoferus senex* Wollaston, 1854

## 26. *Trichoferus griseus* Fabricius, 1793

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Sheer, 38.0 m, 35°51'16.8"E, 35°31'38.3"N, 13.IX.2014 (2 females)/Al-Sanobar, 32.0 m, 35°53'7.05"E, 35°28'45.82"N, 14.X.2012 (2 males); 6.X.2104 (2 males)/Tisheen University Campus, 31.0 m, 35°48'25.7"E, 35°31'29.0"N, 3.V.2013 (2 males). Qardahah Area: Al-Qarer, 15.0 m, 35°54'46.29"E, 35°8'8.52"N, 9.IX.2103 (2 males)/Siano, 78.0 m, 35°59'39.73"E, 35°22'12.64"N, 12.XI.2010 (2 females); 7.IX.2013 (2 males, 2 females). Haffa Area: Sharifa, 300.0 m, 36°0'45.11"E, 35°37'28.03"N, 11.X.2014 (2 males).



CHOROTYPE. Mediterranean (Özdikmen, 2008a).

BIONOMICS. Usually monophagous on *Ficus carica*; life cycle usually takes one year; adults are usually encountered between June–August.

REMARKS. Widly spread in SCR; samples were collected by hand from *Ficus carica* L. trees, or by intercepting traps situated in some orchards containing *Ficus* sp. trees.

Tribe Hylotrupini Zagajkevitch, 1991

Genus *Hylotrupes* Audinet-Serville, 1834

Type species: *Cerambyx bajulus* Linnaeus, 1758

27. *Hylotrupes bajulus* Linnaeus, 1758

EXAMINED MATERIAL. Latakia Province. Latakia Area: Serskieh, 55.0 m, 35°55'10.40"E, 35°42'19.84"N, 17.VII.014 (2 males, 1 female).

Tartus Province. Baniyas Area: Kherbet Al-Sansel, 242.0 m, 35°58'20.48"E, 35°10'2.15"N, 7.V.2014 (1 male).

CHOROTYPE. Subcosmopolitan (Özdikmen, 2008b).

BIONOMICS. Larvae usually feed on dead wood of *Pinus*, *Picea*, *Abies*; life cycle usually take 2–9 years; adults are usually encountered between June–September.

REMARKS. Not frequently encountered in SCR, the first species was collected from a wall near a light bulb during the night; the other specimen emerged from a dying *Vitis* sp. vine.

Tribe Molorchini Gistel, 1848

Genus *Molorchus* Fabricius, 1793

Type species: *Necydalis umbellatarum* Schreber, 1759

Subgenus *Caenoptera* C.G. Thomson, 1859

Type species: *Necydalis minor* Linnaeus, 1758

28. *Molorchus (Caenoptera) juglandis* Sama, 1982

EXAMINED MATERIAL. Latakia Province. Latakia Area: Mashqita, 88.0 m, 35°53'51.0"E, 35°39'34.1"N, 16. VI. 2013 (1 male).

CHOROTYPE. E-Mediterranean (Palestino-Taurian) or SW-Asiatic (Özdikmen, 2014a).

BIONOMICS. Monophagous on walnut trees (*Juglans regia* L.); life cycle usually takes 1–2 years; adults are usually encountered between May–June.

REMARKS. This is the first record of this species in Syria. The specimen was collected by the hand from the flowers of an Apiaceae plant.

Tribe Phoracanthini Newman, 1840

Genus *Phoracantha* Newman, 1840

Type species: *Stenocorus semipunctatus* Fabricius, 1775

29. *Phoracantha recurva* Newman, 1840

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 3.VIII.2014 (2 males)/Al-Bassa, 27.5 m, 35°50'51.9"E, 35°29'59.2"N, 3.V.2013 (1 male, 2 female)/Demsarkho, 17.0 m, 35°46'36.8"E, 35°33'12.6"N, 16.IV.2013 (1 male)/ Fattiro, 111.0 m, 35°51'11.3"E, 35°37'21.7"N, 21.X.2013 (3 males)/Kirsana, 63.0 m, 35°49'38.4"E, 35°37'4.34"N, 21.XI.2011 (2 males)/Tisheen University Campus: 31.0 m, 35°48'25.7"E, 35°31'29.0"N, 21.XI.2011 (2 males). Jableh Area: Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 11.X.2012 (2 females)/Sakhabe, 148.0 m, 36° 1'54.53"E, 35°19'5.58"N, 13.IX.2013 (2 males). Haffa Area: As-Samia, 197.0 m, 35°59'20.56"E, 35°33'16.80"N, 16.VII.2011 (2 males); 12.XI.2012 (2 males)/Mzeraah, 515.0 m, 36°4'19.18"E, 35°31'59.55"N, 13.XI.2014 (3 males).

Tartus Province. Tartus Area: Al-Sawda, 314.0 m, 35°56'37.80"E, 34°58'55.93"N, 1.X.2011 (2 males, 1 female)/Tartus, 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 25. X. 2012 (2 males). Baniyas Area: Baniyas, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 16. VI. 2012 (1 male). Safita Area: Safita, 310.0 m, 36° 7'5.14"E, 34°49'1.75"N, 16. V. 2013 (2 males).

CHOROTYPE. Cosmopolitan (Özdikmen, 2011).

BIONOMICS. Monophagous on *Eucalyptus* spp.; life cycle usually takes one year; adults usually encountered between April–October.

REMARKS. This is the first record of this species from Syria. It frequently encountered in SCR, especially on or near *Eucalyptus* sp. stands, specimens were collected by hand from the trunks of some deciduous trees; some specimens were collected from light traps.

30. *Phoracantha semipunctata* Fabricius, 1775

EXAMINED MATERIAL. Latakia Province. Latakia Area: Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 13.IX.2012 (1 male).

CHOROTYPE. Cosmopolitan (Özdikmen, 2011).

BIONOMICS. Monophagous on *Eucalyptus* spp.; life cycle usually takes one year; adults are usually encountered between April–October.

REMARKS. It is a very rare species in SCR; as a result, it is usually, erroneously, identified as *Phoracantha recurva*. The specimen was collected by hand from the wall of a house near a light source.

Tribe Purpuricenini J. Thomson, 1861

Genus *Purpuricen* Dejean, 1821

Type species: *Cerambyx kaehler* Linnaeus, 1758

31. *Purpuricen* *budensis* Götz, 1783

EXAMINED MATERIAL. Latakia Province. Latakia Area: Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 5.X.2104 (2 females); 8.X.2014 (2 males); 25.X.2014 (3 males)/Kamlieh, 242.0 m, 35°54'6.06"E, 35°40'5.31"N, 15. VIII. 2011 (2 males); 16.IX.2012 (2 males)/Qismin, 191.0 m, 35°54'18.6"E, 35°38'1.2"N, 25.XI.2014 (2 males, 1 female)/Latakia, 20.0 m, 35°46'51.7"E, 35°31'47.1"N, 6.XI.2014 (2 males, 1 female)/Tisheen University Campus, 31.0 m, 35°48'25.7"E, 35°31'29.0"N, 25.XI.2014 (1 male, 2 female).

Tartus Province. Baniyas Area: Faresh Ka3bieh, 301.0 m, 36° 1'18.71"E, 35°11'20.04"N, 25.X.2014 (3 males)/Kirkafti, 77.0 m, 35°56'55.35"E, 35° 4'32.53"N, 2.X.2014 (3 males)/Srijis, 585.0 m, 36°10'59.04"E, 34°55'55.51"N, 6.X.2014 (3 females); 22.X.2014 (2 male). Safita Area: Safita, 310.0 m, 36° 7'5.14"E, 34°49'1.75"N, 28.XI.2014 (2 females).

CHOROTYPE. Turano-European-Mediterranean (Özdikmen, 2011).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Prunus*, *Quercus*, *Salix*, *Pistacia*, *Ulmus*); life cycle usually takes 2–3 years; adults are usually encountered between May–August.

REMARKS. Widely spread in SCR. Specimens were collected by hand from trunks and branches of deciduous trees, especially oak (*Quercus* spp.) trees.

32. *Purpuricen* *dalmatinus* Sturm, 1843

EXAMINED MATERIAL. Latakia Province. Latakia Area: Kamlieh, 242.0 m, 35°54'6.06"E, 35°40'5.31"N, 16.X.2014 (2 males).

Tartus Province. Tartus Area: Beit Alian, 56.0 m, 35°56'17.91"E, 34°51'13.93"N, 4.X.2014 (1 female). Baniyas Area: Srijis, 585.0 m, 36°10'59.04"E, 34°55'55.51"N, 5. VI. 2013 (1 male).

CHOROTYPE. E-Mediterranean (Ozdikmen, 2011).

BIONOMICS. Monophagous on oak trees (e.g. *Quercus coccifera* L., *Q. conferta* Kit.; life cycle usually takes 2–3 years; adults are usually encountered between May–July.

REMARKS. Relatively rare in SCR. Specimens were collected by hand from oak (*Quercus* spp.) forests.

Tribe Stenopterini Gistel, 1848

Genus *Lampropter* Mulsant, 1862

Type species: *Necydalis femoratus* Germar, 1824

33. *Lampropter* *femoratus* Germar, 1824

EXAMINED MATERIAL. Tartus Province. Baniyas Area: Beit Al-Marj, 516.0 m, 36° 4'58.55"E, 35° 6'34.81"N, 18.VI.2014 (1 male, 1 female).

CHOROTYPE. E-Mediterranean or S-E European (Özdikmen, 2014)

BIONOMICS. Polyphagous on deciduous trees, e.g. *Quercus*, *Q. ithaburensis*, *Q. calliprinos* Webb., *Delonyx regia* (Bojer ex Hook.) Raf., *Acer*, *Ulmus*; life cycle usually takes 1–2 years; adults are usually encountered between May–July.

REMARKS. This is the first record of this species from both Syria, and Asia. It is an extremely rare species in SCR, larvae and adults were obtained from a live *Prunus* sp. tree.

Genus *Stenopter* Illiger, 1804

Type species: *Necydalis rufa* Linnaeus, 1767



34. *Stenopterus flavicornis* Küster, 1846

EXAMINED MATERIAL. Tartus Province. Baniyas Area: Al-Marana, 578.0 m, 36° 5'14.71"E, 35°12'50.69"N, 7.VIII.2012 (1 male).

CHOROTYPE. E-European (Özdikmen, 2011).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Ceratonia siliqua*, *Cercis siliquastrum*, *Citrus cinensis* L., *Cotoneaster franchetii* Bois, *Pistacia atlantica*, *Quercus ithaburensis*, *Quercus calliprinos*; life cycle usually takes two years; adults are usually encountered between May–August.

REMARKS. Rare species in SCR; the specimen was collected by hand from the flowers of an Apiaceae plant.

35. *Stenopterus rufus syriacus* Pic, 1892

EXAMINED MATERIAL. Tartus Province. Shayk-Badr Area: Al-Msherfeh, 270.0 m, 35°59'57.49"E, 35° 9'40.74"N, 15.VIII.2012 (1 male, 1 female).

CHOROTYPE. E-Mediterranean/Palaestino-Taurian (Özdikmen, 2011).

BIONOMICS. Polyphagous on deciduous trees (e.g. *Quercus*, *Castanea*, *Robinia*, *Junglans*, *Prunus*, *Salix*, *Paliurus*, *Pistacia*, *Ulmus*, *Ficus*, *Ostrya*); life cycle usually takes two years; adults are usually encountered between May–August.

REMARKS. Relatively a rare species in SCR; specimens were collected by hand from the flowers of an Asteraceae plant.

Subfamily Lamiinae Latreille, 1825

Tribe Acanthocinini Blanchard, 1845

Genus *Acanthocinus* Dejean, 1821

Type species: *Cerambyx aedilis* Linnaeus, 1758

36. *Acanthocinus griseus* Fabricius, 1793

EXAMINED MATERIAL. Latakia Province. Qardahah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 16.IX.2013 (1 male, 1 female)/ Deir Hanna, 221.0 m, 36° 2'2.82"E, 35°25'47.94"N, 17. X. 2014 (1 female).

CHOROTYPE. Sibero-European (Özdikmen, 2011).

BIONOMICS. Oligophagous mainly on coniferous trees (e.g. *Pinus*, *Picea*, *Abies*); life cycle usually

takes 1–2 years; adults are usually encountered between April–August.

REMARKS. This is the first record of this species in both Syria and the Middle East.

It is a rather rare species in SCR; the specimen was collected on the trunk of a pine tree *Pinus* sp.

Genus *Leiopus* Audinet-Serville, 1835

Type species: *Cerambyx nebulosus* Linnaeus, 1758

37. *Leiopus (s.str.) syriacus* Ganglbauer, 1884  
*Leiopus major* Pic, 1898

EXAMINED MATERIAL. Latakia Province. Latakia Area: Salib al-Turkmen: 52.0 m, 35°48'49.98"E, 35°41'14.76"N, 16.IV.2014 (1 male).

CHOROTYPE. The chorotype is East-Mediterranean/Palaestino-Taurian (Özdikmen, 2008b).

BIONOMICS. Oligophagous deciduous trees; life cycle usually takes 2 years; adults are usually encountered between April–June.

REMARKS. It is a rather rare species in SCR; the specimen was collected on the trunk of an oak tree *Quercus* sp.

Tribe Agapanthiini Mulsant, 1839

Genus *Agapanthia* Audinet-Serville, 1835

Type species: *Cerambyx cardui* Linnaeus, 1767

38. *Agapanthia (s. str.) lais* Reiche et Saulcy, 1858

EXAMINED MATERIAL. Latakia Province. Jableh Area: Bustan Al-Basha, 33.0 m, 35°56'3.35"E, 35°25'26.46"N, 5.V.2013 (2 males, 1 female).

Tartus Province. Tartus Area: Doir Sheik Saad, 104.0 m, 35°55'0.23"E, 34°55'2.54"N, 18.IX.2014 (2 males).

CHOROTYPE. E-Mediterranean/Palaestino-Taurian (Özdikmen, 2013).

BIONOMICS. Oliphagous on various Asteraceae plants, it is also recorded on *Onopordon macrocephalum* Eig in Syria; life cycle usually takes one year; adults are usually encountered between May–June.

REMARKS. Frequently encountered in SCR. Specimens were encountered on Apiaceae and Asteraceae plants.

39. *Agapanthia* (s. str.) *suturalis* Fabricius, 1787

EXAMINED MATERIAL. Latakia Province. Jableh Area: Besaysin, 29.0 m, 35°57'12.27"E, 35°20'53.43"N, 20.IV.2012 (2 males)/Kirfis, 210.0 m, 35°59'17.31"E, 35°16'5.79"N, 13.V.2012 (1 male).

CHOROTYPE. Mediterranean (Özdikmen, 2013).

BIONOMICS. Polyphagous on herbaceous plants: *Valeriana officinalis* L., *Salvia pratensis* L., *Knautia arevensis* (L.) Coulter, *Jasonia montana* L., *Cirsium*, *Carduus*, *Melilotus*, etc.; life cycle usually takes one year; adults are usually encountered between March–July.

REMARKS. Relatively rare in SCR. Specimens were collected on Lamiaceae plants. This species was previously regarded as a form of *Agapanthia cardui* (Linnaeus, 1757), but has recently been considered a distinct species (Sama et al., 2010).

Subgenus *Epopetes* Gistel, 1857

Type species: *Lamia asphodeli* Latreille, 1804

40. *Agapanthia* (*Epopetes*) *coeruleipennis* Frivaldsky, 1878

EXAMINED MATERIAL. Latakia Province. Jableh Area: Dairon, 381.0 m, 36° 8'19.82"E, 34°59'2.40"N, 16.VII.2014 (2 males).

CHOROTYPE. SW-Asiatic (Özdikmen, 2013).

BIONOMICS. Monophagous on *Gundelia tournefortii* L. (Asteraceae); life cycle usually takes one year; adults are usually encountered between May–June.

REMARKS. Very rare in SCR, the specimen was encountered on the host plant.

41. *Agapanthia* (*Epopetes*) *pustulifera* Pic, 1905

EXAMINED MATERIAL. Latakia Province. Latakia Area: Janatah, 108.0 m, 35°49'49.4"E, 35°35'01.9"N, 16.VII.2011 (1 male)/Kirsana, 63.0 m, 35°49'38.4"E, 35°37'4.34"N, 7.X.2013 (1 male, 1 female). Jableh Area: Besaysin, 29.0 m, 35°57'12.27"E, 35°20'53.43"N, 20.IV.2012 (1 male); 7.VI.2012 (1 female). Qardahah Area: Deir Hanna, 221.0 m, 36° 2'2.82"E, 35°25'47.94"N, 10.X.2012 (1 male).

CHOROTYPE. Unkown. Distribution: Asia (Jordan, Lebanon, Palestine, and Syria).

BIONOMICS. Develops in stems and stalks of herbaceous plants: e.g. *Asphodelus* sp., *Carduus*, *Carthamus*, *Eremostachys laciniata* (L.) Bunge, *Centaurea iberica* Trevir. et Spreng.; life cycle usually takes one year; adults are usually encountered between May–June.

REMARKS. Relatively widespread in SCR. Specimens were collected on herbaceous plants.

Genus *Calamobius* Guérin-Méneville, 1847

Type species: *Saperda gracilis* Creutzer, 1799 (= *Saperda filum* Rossi, 1790)

42. *Calamobius filum* Rossi, 1790

EXAMINED MATERIAL. Latakia Province. Jableh Area: Bustan Al-Basha, 33.0 m, 35°56'3.35"E, 35°25'26.46"N, 5.V.2013 (2 males, 1 female).

CHOROTYPE. Turano-European-Mediterranean (Özdikmen et al., 2010).

BIONOMICS. Oligophagous on various Poaceae: *Hedysarum*, *Hordeum*, *Triticum*, *Arrhenaterum*, *Calamogrotis*, *Dactylis*; life cycle usually takes one year; adults are usually encountered between April–July.

REMARKS. Not quite frequently encountered in SCR; specimens were collected by hand from Gramineae plants.

Tribe Batocerini J. Thomson, 1864

Genus *Batocera* Dejean, 1835

Type species: *Cerambyx rubus* Linnaeus, 1758

43. *Batocera rufomaculata* DeGeer, 1775

EXAMINED MATERIAL. Latakia Province. Latakia Area: Ain Al-Beida, 6.0 m, 35°53'34.2"E, 35°39'28.7"N, 11.IX.2012 (2 males)/Al-Bahlouliyah, 224.0 m, 35°57'20.7"E, 35°38'0.6"N, 28.X.2012 (1 male); 9.XI.2012 (2 males, 1 female); 15. VI. 2013 (2 males); 4.IX.2014 (2 males)/Al-Hannadi, 73.5 m, 35°52'53.5"E, 35°30'10.5"N, 6.VIII.2012 (1 male); 3.IX.2013 (2 males, 1 female)/Dibba, 32.0 m, 35°54'36.18"E, 35°32'18.46"N, 8.VIII.2013 (1 male, 1 female); 15.VIII.2014 (2 female)/Fakhoura,



183.0 m, 35°58'17.46"E, 35°29'7.54"N, 29.X.2014 (3 males)/Bouka, 62.0 m, 35°48'32.26"E, 35°32'17.80"N, 9.X.2012 (2 female); 13.IX.2014 (1 female)/Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 1.VII.2013 (3 males); 7.X.2013 (1 male); 16.VIII.2014 (2 males); 29.IX.2014 (2 males)/Bdamioun, 66.0 m, 35°54'38.57"E, 35°35'33.84"N, 15.X.2012 (1 male); 18.IX.2014 (1 male)/Baksa, 89.0 m, 35°49'18.33"E, 35°34'15.2"N, 16.X.2012 (1 male)/Al-Tarquia, 81.0 m, 35°57'12.55"E, 35°39'51.55"N, 10.X.2014 (3 males); 3.VII.2014 (1 male, 1 female)/Al-Sanobar, 32.0 m, 35°53'7.05"E, 35°28'45.82"N, 18.X.2013 (3 males); 21.XI.2013 (2 males, 1 female)/Al-Shabatliyah, 178.0 m, 35°49'38.8"E, 35°41'10.3"N, 16.X.2012 (1 male); 7.X.2013 (1 male, 1 female)/Al-Shilfatiyah, 45.0 m, 35°53'57.6"E, 35°32'21.5"N, 26.IX.2013 (1 male, 4 female)/Al-Sheer, 38.0 m, 35°51'16.8"E, 35°31'38.3"N, 13.X.2013 (1 male, 2 females)/Al-Qanjara, 72.45 m, 35°52'25.1"E, 35°30'43.4"N, 25.V.2013 (2 males)/Al-Mrouj, 5.0 m, 35°45'35.6"E, 35°34'41.1"N, 21.X.2011 (1 female); 7.IX.2013 (3 males)/Demsarkho: 17.0 m, 35°46'36.8"E, 35°33'12.6"N, 28.VI.2011 (1 male); 11.X.2012 (1 male); 7.X.2014 (1 male, 1 female); 13.X.2014 (2 males, 1 female)/Jbarioun, 15.0 m, 35°53'20.43"E, 35°34'22.27"N, 16.X.2012 (1 male); 29.X.2012 (1 male)/Kamlieh, 242.0 m, 35°54'6.06"E, 35°40'5.31"N, 15.X.2011 (1 male)/Kirsana, 63.0 m, 35°49'38.4"E, 35°37'4.34"N, 26.IX.2014 (1 male, 1 female)/Latakia, 20.0 m, 35°46'51.7"E, 35°31'47.1"N, 20.XI.2014 (3 males)/Mashqita, 88 m, 35°53'51.0"E, 35°39'34.1"N, 8.VII.2011 (1 female), Mazar Al-Qatria, 142.0 m, 35°55'32.1"E, 35°30'56.0"N, 15.X.2013 (1 male)/Qismin, 191.0 m, 35°54'18.6"E, 35°38'1.2"N, 2.X.2011 (3 males); 17.IV.2013 (1 male, 1 female)/Ras Al-Basit, 21.0 m, 35°50'21.33"E, 35°50'47.86"N, 10.XI.2 (2 males)/Sit-Kheris, 55.0 m, 35°54'4.01"E, 35°34'10.43"N, 25.VII.2012 (2 males); 15.IX.2013 (1 male); 19.IX.2014 (3 males)/Sqoubin, 116.0 m, 35°49'52.8"E, 35°33'35.2"N, 17.X.2011 (2 males)/Tishreen University Campus, 31.0 m, 35°48'25.7"E, 35°31'29.0"N, 1.XI.2012 (2 males); 3.IV.2013 (1 female); 19.X.2104 (2 males); 15.XI.2014 (2 males)/Tishreen Suburb, 66.0 m, 35°48'19.81"E, 35°32'3.46"N, 27.VII.2014 (1 male)/Zobar, 160.0 m, 35°58'53.81"E, 35°37'14.55"N, 26.X.2011 (1 female). Jableh Area: Ain Shkak, 61.0

m, 35°58'54.93"E, 35°23'2.60"N, 15.X.2012 (2 males)/Al-Barzin, 370.0 m, 36°1'21.46"E, 35°15'14.05"N, 5.X.2013 (4 males)/Al-Eidia, 40.0 m, 35°58'33.97"E, 35°17'9.67"N, 6.XI.2014 (3 males)/Al-Hwaiz: 107.0 m, 36°0'27.93"E, 35°20'20.17"N, 13.IX.2013 (3 males); 25.X.2014 (2 males)/Al-Kalaie, 185.0 m, 36°2'31.34"E, 35°21'17.62"N, 6.V.2011 (3 males); 2.IX.2012 (1 male, 1 female); 6.VIII.2013 (2 males); 7.IX.2014 (1 male)/Besaysin, 29.0 m, 35°57'12.27"E, 35°20'53.43"N, 7.X.2013 (2 females); 17.X.2013 (1 male, 1 female); 12.IX.2014 (2 males); 13.X.2014 (1 male); 12.XI.2014 (3 males); 16.XI.2014 (2 males, 1 female)/Ghnieri, 146.0 m, 36°1'0.01"E, 35°21'6.01"N, 5.X.2012 (2 males); 2.X.2011 (1 male, 3 females)/Hmimim, 40.0 m, 35°57'1.30"E, 35°22'34.65"N, 12.VIII.2014 (2 males)/Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 1.XII.2011 (1 male); 25.VII.2013 (3 males, 2 females); 15.IX.2013 (1 female); 21.IX.2013 (4 males, 2 females); 23.IX.2013 (3 males); 16.X.2013 (3 males, 1 female)/Kirfis, 210.0 m, 35°59'17.31"E, 35°16'5.79"N, 31.VIII.2014 (3 males, 1 female)/Qutaolabyah, 215.0 m, 36°1'8.98"E, 35°17'13.14"N, 27.IX.2013 (1 male, 1 female); 20.X.2013 (6 males, 2 females); 23.X.2013 (1 male); 25.X.2013 (3 males); 7.X.2014 (1 male)/Ras Al-Ain, 133.0 m, 36°0'38.71"E, 35°19'26.72"N, 20.VII.2011 (2 females); 9.X.2011 (2 males); 18.IV.2014 (2 males); 13.IX.2014 (2 males)/Rmelieh, 14.0 m, 35°55'26.93"E, 35°22'54.71"N, 11.XI.2013 (2 males)/Siano, 78.0 m, 35°59'39.73"E, 35°22'12.64"N, 17.X.2012 (2 males); 13.IX.2014 (2 males). Qardahah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 5.VII.2013 (1 male); 5.X.2013 (3 males); 22.X.2013 (2 males); 13.X.2014 (2 males)/Al-Qarer, 15.0 m, 35°54'46.29"E, 35°8'8.52"N, 10.XI.2012 (1 male)/Istamou, 73.0 m, 35°54'8.48"E, 35°29'51.27"N, 3.IV.2014 (1 male)/Yerti, 380.0 m, 36°2'53.76"E, 35°31'5.68"N, 7.X.2014 (1 male); 16.X.2014 (1 male, 1 female). Haffa Area: Ain Al-Tienah, 644.0 m, 36°5'37.51"E, 35°33'45.76"N, 15.IX.2012 (1 female)/Al-Haffah, 272.0 m, 36°1'59.38"E, 35°35'41.57"N, 2.V.2011 (1 male); 7.IX.2013 (2 males)/Ghornata, 246.0 m, 35°59'42.00"E, 35°33'35.95"N, 3.IV.2013 (1 male); 15.X.2013 (1 male)/Manjila, 75.0 m, 35°55'16.19"E, 35°32'56.26"N, 22.IX.2013 (2 males)/Mzeraah, 515 m, 36°4'19.18"E, 35°31'59.55"N, 25.X.2013 (1 male); 5.IV.2014 (2 males); 13.X.2014 (2 males)/



Salma, 720.0 m, 36°8'12.32"E, 35°41'22.85"N, 24.X.2011 (1 male)/Slunfeh, 1056.0 m, 36°10'44.28"E, 35°36'0.81"N, 2.XI.2013 (2 males); 16.XI.2013 (1 male, 1 female)/ Terjano, 110.0 m, 35°59'15.20"E, 35°31'44.06"N, 25.IX.2014 (2 males); 20.X.2013 (3 males).

Tartus Province. Tartus Area: Al-Karimeh, 185.0 m, 36°2'31.34"E, 35°21'17.62"N, 6.X.2011 (4 males)/As-Sifsafah, 130.0 m, 36°2'55.04"E, 34°43'57.80"N, 4.V.2013 (1 male)/Matin Bouria, 240.0 m, 35°57'4.38"E, 35°2'10.67"N, 7.IX.2013 (1 male); 16.V.2014 (1 male)/Nakib, 168.0 m, 35°59'3.16"E, 34°51'16.23"N, 7.XI.2014 (1 male)/Saya 216.0 m, 35°56'55.30"E, 35°2'46.23"N, 26.X.2014 (2 males)/ Tartus, 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 18.VI.2012 (1 female); 3.VI.2013 (2 males, 3 females). Baniyas Area: Al-Mawsheh, 254.0 m, 35°58'40.36"E, 35°3'51.05"N, 9.XI.2012 (2 males); 15.IV.2013 (2 males)/Al-Qadmus, 919.0 m, 36°9'40.13"E, 35°6'6.53"N, 9. X. 2012 (1 male); 17.V.2013 (1 male); 14.X.2014 (2 males)/Al-Roudah: 150.0 m, 35°54'53.46"E, 35°4'2.91"N, 15.V.2013 (2 males)/Baniyas: 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 10.VIII.2011 (1 male); 6.X.2011 (3 males); 10.X.2012 (1 male); 29.X.2012 (1 male); 29.X.2012 (1 male); 16.VIII.2013 (3 males, 2 females); 29.X.2013 (3 males); 16.IX.2014 (3 males, 1 female); 28.IX.2014 (2 males)/Btilleh, 145.0 m, 35°59'44.17"E, 35°12'31.74"N, 10.X.2012 (1 male)/Deir Al-Bishl: 101.0 m, 35°58'56.27"E, 35°11'48.97"N, 7.V.2013 (1 male)/Faresh Kaebieh, 301.0 m, 36°1'18.71"E, 35°11'20.04"N, 16.VII.2014 (1 male)/ Isqublh: 690.0 m, 36°3'39.70"E, 35°9'54.14"N, 9.X.2013 (1 male)/Hreisoun, 14.0 m, 35°57'23.63"E, 35°14'8.88"N, 3.X.2013 (1 male); 17.IX.2014 (4 males); 12.X.2014 (3 males); 6.XII.2013 (2 males); 8.VIII.2014 (2 females); 27.X.2014 (2 males); 15.XI.2014 (3 males)/Mihourti, 131.0 m, 35°58'45.84"E, 35°14'53.08"N, 3.XI.2012 (2 males, 3 females)/Srijis, 585.0 m, 36°10'59.04"E, 34°55'55.51"N, 4.XI.2011 (2 males); 14.IX.2012 (2 males)/ Wadi Al-Saki, 519.0 m, 36°5'26.53"E, 35°6'2.64"N, 26.VI.2014 (2 males)/Zoubah, 407.0 m, 35°58'45.50"E, 35°7'14.92"N, 4. IX. 2013 (3 males, 2 females); Q 6.IX. 013 (3 males). Safita Area: Safita, 310.0 m, 36°7'5.14"E, 34°49'1.75"N, 22.IX.2012 (1 male); 19.XI.2012 (2 females); 23.XI.2012 (1 male); 19.X.2013 (2 males, 1 female); 9.XI.2014 (5 males); 14.XI.2013 (4 males). Shayk-Badr Area: Ash Shayk

Badr, 491.0 m, 36°4'52.70"E, 34°59'25.23"N, 19.IX.2013 (4 males, 2 females)/ Darti, 278.0 m, 35°59'18.70"E, 35°4'48.29"N, 15.V.2013 (2 males)/Kfarieh: 368.0 m, 36°4'20.62"E, 34°58'17.16"N, 15.X.2013 (2 males, 3 females)/Qamsyiah: 398.0 m, 35°59'31.46"E, 35°3'11.38"N, 16.IX.2012 (1 male, 1 female). Draykish Area: Draykish, 470.0 m, 36°8'3.44"E, 34°53'50.65"N, 16.V.2012 (1 male); 5.VI.2014 (1 female).

CHOROTYPE. Afrotropico-Indo-Mediterranean+ Neotropic (Özdikmen et al., 2010).

BIONOMICS. Oligophagous on deciduous trees: *Ficus rubiginosa* Desf. ex Vent., *Morus alba*, *Avocado*, *Ceratonia siliqua*; life cycle usually takes one year; adults are usually encountered between June–September.

REMARKS. Extremely widespread, and its distribution covers the whole area of SCR. Specimens were collected in large numbers from light traps and from walls near light sources in almost every area of the Coastal Strip, other specimens were collected by hand from tree trunks and branches, especially *Ficus* spp. trees. It is one of the most destructive pests to the fig trees in SCR, and often considered noxious and often killed by farmers.

Tribe Monochamini Gistel, 1848

Genus *Monochamus* Dejean, 1821

Type species: *Cerambyx sutor* Linnaeus, 1758

#### 44. *Monochamus galloprovincialis tauricola* Germar, 1818

EXAMINED MATERIAL. Latakia Province. Qardahah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 16.VIII.2012 (1 male).

CHOROTYPE. Sibero-European (Özdikmen, 2008).

BIONOMICS. Monophagous on pine (*Pinus* spp.); life cycle usually takes 1–2 years; adults are usually encountered between May–September.

REMARKS. This is the first record of this species in Syria. It is a very rare species in SCR; the specimen was collected by hand from the trunk of a pine *Pinus* sp. tree.

Tribe Phytoeciini Mulsant, 1839

Genus *Oberea* Dejean, 1835

Type species: *Cerambyx linearis* Linnaeus, 1760



45. *Oberea* (s. str.) *oculata* Linnaeus, 1758  
*Oberea borysthena* Mokrzecki, 1900  
*Oberea inoculata* Heyden, 1892  
*Oberea quadrimaculata* Donisthorpe, 1913  
*Oberea tomensis* Kiseleva, 1927

EXAMINED MATERIAL. Latakia Prov., Latakia Area: Al-Hannadi, 73.5 m, 35°52'53.5"E, 35°30'10.5"N, 16.VI.2014 (1 male).

CHOROTYPE. Palaearctic (Özdikmen et al., 2009).

BIONOMICS. Monophagous on willow (*Salix* spp.); life cycle usually takes 1–2 years; adults are usually encountered between June–September.

REMARKS. Not widely spread in SCR, and can be considered rare, the specimen was collected by the hand from a willow (*Salix* sp.) tree.

Genus *Phytoecia* Dejean, 1835

Type species: *Cerambyx cylindricus* Linnaeus, 1758

46. *Phytoecia* (s. str.) *caerulea bethseba* Reiche et Saulcy, 1858

EXAMINED MATERIAL. Latakia Province. Qardah Area: Al-Qardahah, 310.0 m, 36°3'36.19"E, 35°27'28.76"N, 13.IX.2011 (1 male).

Tartus Province. Safita Area: Safita, 310.0 m, 36° 7'5.14"E, 34°49'1.75"N, 16.V.2012 (1 male).

CHOROTYPE. Unknown. Distribution: Asia (Jordan, Lebanon, Palestine, and Syria).

BIONOMICS. Oligophagous on various Brassicaceae and Boraginaceae: *Sinapis*, *Sisymbrium*, *Rapistrum*, *Echium*, *Cerinthe*, *Cynoglossum*, *Anchusa*, *Symphytum*, *Lithospermum*, *Lappula*, *Lycopsis*); life cycle usually takes one year; adults are usually encountered between April–June, and sometimes earlier between February–May.

REMARKS. Not frequently encountered in SCR; specimens were collected by the hand from the flowers of Brassicaceae plants. The current pattern of distribution suggests an E-Mediterranean chorotype.

47. *Phytoecia* (s. str.) *rufipes latior* Pic, 1895

EXAMINED MATERIAL. Latakia Province. Haffa Area: Slunfeh, 1056.0 m, 36°10'44.28"E, 35°36'0.81"N, 16.VIII.2013 (1 male).

CHOROTYPE. Unknown. Distribution: Syria, and Turkey.

BIONOMICS. Host plants are unknown; life cycle usually takes one year; adults are usually encountered between May–June.

REMARKS. Quite a rare species in SCR. The specimen was collected by sweeping herbaceous plants with an entomological net. The current pattern of distribution suggests a SW-Asiatic /Syro-Anatolian chorotype.

Subgenus *Helladia* Fairmaire, 1864

Type species: *Saperda flavescens* Brullé, 1832

48. *Phytoecia* (*Helladia*) *alziari* Sama, 1992

EXAMINED MATERIAL. Tartus Province. Safita Area: Safita, 310.0 m, 36° 7'5.14"E, 34°49'1.75"N, 22.V.2014 (2 males).

CHOROTYPE. SW-Asiatic, or E-Mediterranean (Özdikmen, 2010b).

BIONOMICS. Monophagous on *Dittrichia viscosa* (L.) Greuter (Asteraceae); life cycle is unknown; adults are usually encountered between March–May.

REMARKS. Not frequently encountered in SCR; specimens were collected by hand from the host plant (Asteraceae).

49. *Phytoecia* (*Helladia*) *humeralis humeralis* Walth, 1838

EXAMINED MATERIAL. Latakia Prov., Latakia Area: Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 16.VII.2013 (1 male).

Tartus Province. Shayk-Badr Area: Darti, 278.0 m, 35°59'18.70"E, 35° 4'48.29"N, 3.VII.2013 (1 female).

CHOROTYPE. SW-Asiatic, or E-Mediterranean (Özdikmen, 2010b).

BIONOMICS. Monophagous on *Centaurea hyalo-lepis* Boiss.; life cycle usually takes one year; adults are usually encountered between April–June.

REMARKS. Not frequently encountered in SCR; specimens were collected by sweeping herbaceous plants with an entomological net.

Subgenus *Pilemia* Fairmaire, 1864

Type species: *Phytoecia tigrina* Mulsant, 1851

50. *Phytoecia (Pilemia) griseomaculata* Pic, 1891

EXAMINED MATERIAL. Tartus Province. Baniyas Area: Mihourti, 131.0 m, 35°58'45.84"E, 35°14'53.08"N, 31.V.2013 (3 males, 1 female).

CHOROTYPE. SW-Asiatic/Syro-Anatolian (Özdikmen, 2010a): Syria, and Turkey.

BIONOMICS. Monophagous on *Anchusa* cf. *barrelieri* (All.) Vitman (Boraginaceae); life cycle usually takes one year; adults are usually encountered during June.

REMARKS. Rather rare in SCR. Specimens were collected from the flowers of a herbaceous plant late in autumn.

Tribe Pteropliini J. Thomson, 1860

Genus *Niphona* Mulsant, 1839

Type species: *Niphona picticornis* Mulsant, 1839

51. *Niphona (s. str.) picticornis* Mulsant, 1839

EXAMINED MATERIAL. Latakia Prov. Latakia Area: Al-Hannadi, 73.5 m, 35°52'53.5"E, 35°30'10.5"N, 20.X.2013 (4 males)/Al-Shamyiah, 55.0 m, 35°48'27.8"E, 35°38'13.3"N, 3.VI.2014 (2 males, 2 females)/ Balloran, 193.0 m, 35°53'35.30"E, 35°46'40.52"N, 14.X.2011 (2 males)/Bisnada, 21.0 m, 35°48'14.97"E, 35°32'52.65"N, 13.IV.2013 (1 male)/Dahtour, 23.0 m, 35°47'33.18"E, 35°33'13.22"N, 25.X.2014 (1 male)/Kamlieh, 242.0 m, 35°54'6.06"E, 35°40'5.31"N, 2.X.2012 (2 males)/Khreibeh: 816.0 m, 36°6'11.91"E, 35°17'26.83"N, 5.IV.2013 (1 male)/Kirsana: 63.0 m, 35°49'38.4"E, 35°37'4.34"N, 12.XI.2013 (1 male)/Latakia, 20.0 m, 35°46'51.7"E, 35°31'47.1"N, 24.X.2014 (2 males); 11.IX.2014 (1 male)/Raboueh, 700.0 m, 35°58'54.48"E, 35°54'31.40"N, 12.XI.2014 (1 male)/Zakizkanieh, 54.0 m, 35°48'29.85"E, 35°31'47.30"N, 7.X.2013 (1 male). Jableh Area: Al-Louzeh, 24.0 m, 35°56'27.99"E, 34°48'29.73"N, 21.X.2014 (1 male)/ Bustan Al-Basha, 33.0 m, 35°56'3.35"E, 35°25'26.46"N, 7.IX.2014 (2 males)/Dairon, 381.0 m, 36°8'19.82"E, 34°59'2.40"N, 3.IV.2014 (2 males)/Dwaer Baabda, 606.0 m, 36° 2'41.58"E,

35°14'54.99"N, 6. XI. 2014 (2 males, 1 female)/Hmimim, 40.0 m, 35°57'1.30"E, 35°22'34.65"N, 3.XI.2014 (2 males)/ Jableh, 20.0 m, 35°8'43.4"E, 35°15'55.2"N, 13.X.2011 (3 males); 1.X.2014 (3 males)/Siano, 78.0 m, 35°59'39.73"E, 35°22'12.64"N, 16.VIII.2013 (2 males); 17.V.2014 (1 male). Qardahah Area: Al-Qardahah, 310.0 m, 36° 3'36.19"E, 35°27'28.76"N, 7.IX.2013 (2 females)/Dibash, 447.0 m, 36° 4'13.50"E, 35°30'50.08"N, 20.X.2014 (1 male). Haffa Area: Al-Haffah, 272.0 m, 36° 1'59.38"E, 35°35'41.57"N, 16.V.2014 (2 males).

Tartus Province. Tartus Area: Al-Khreibat, 82.0 m, 35°56'8.38"E, 34°53'24.19"N, 16.VII.2013 (1 male)/Tartus, 14.0 m, 35°52'59.51"E, 34°53'1.01"N, 9.X.2011 (3 males); 7.X.2013 (2 males). Baniyas Area: Baniyas, 3.0 m, 35°56'24.85"E, 35°10'56.97"N, 7.XI.2013 (3 males, 2 females); 16.VI.2014 (1 male, 1 female)/Baamrael, 122.0 m, 35°59'0.84"E, 35°11'47.78"N, 2.XI.2011 (2 males)/Deir Al-Bishl, 101.0 m, 35°58'56.27"E, 35°11'48.97"N, 6.V.2013 (1 female). Safita Area: Safita, 310.0 m, 36° 7'5.14"E, 34°49'1.75"N, 25.IX.2011 (2 females); 30.IX.2012 (1 male, 1 female); 2.IX.2013 (1 male); 5.XI.2013 (2 males). Shayk-Badr Area: Al-Msherfeh, 270.0 m, 35°59'57.49"E, 35° 9'40.74"N, 12.XI.2012 (2 males); 8.X.2014 (2 males, 2 female)/ Ash Shayk Badr, 491.0 m, 36° 4'52.70"E, 34°59'25.23"N, 19.X.2014 (1 male); 17.XI.2014 (1 male). Draykish Area: Draykish, 470.0 m, 36° 8'3.44"E, 34°53'50.65"N, 22.X.2012 (1 male); 4.IX.2013 (1 male).

CHOROTYPE. Mediterranean (Özdikmen, 2008).

BIOMOMICS. Broadly polyphagous species: *Spartium*, *Pistacia*, *Robinia*, *Castanea*, *Ulmus*, *Punica granatum* L., *Morus*, *Prunus*, *Quercus ilex*, *Q. suber*, *Calycotome*, *Sambucus*, *Laurus*, *Cercis*, *Euphorbia dendroides* L., *Rhamnus*, *Phoenix*, *Genista*; life cycle usually takes two years; adults are usually encountered between April–October.

REMARKS. Widely spread, and its distribution covers all the area of SCR. Specimens were collected by hand from trunks and twigs of *Ficus* sp. trees, and some specimens were collected by sweeping herbaceous plants near forests and orchards.

## CONCLUSIONS

In total 51 species, including 10 subspecies, from 37 genera, 25 tribes and 5 subfamilies of Longhorn



Beetles have been found to inhabit Syrian Coastal Region (Table 1). The complete number of Cerambycid species inhabiting Syria is still unknown.

This study resulted in the first record for 9 species and one subspecies in Syria.

All species mentioned are recorded for the first time in the study area.

Analysis of the biodiversity among Cerambycidae collected from Syrian Coastal Region (e.g. number of identified taxa in each given subfamily) revealed the following data: the biodiversity of the identified subfamilies was analyzed, resulting in 49% of taxa belonging to the subfamily Cerambycinae, 31% to the subfamily Prioninae, 12% to the subfamily Lamiinae, 4% to subfamily Spondylidinae, and 4% to the subfamily Lepturinae (Fig. 1).

Analysis of the biodiversity in study areas of Syrian Coastal Region (e.g. number of identified taxa in each given area) revealed the following data: biodiversity was highest in Latakia area with 20% of taxa collected from that area, followed by Baniyas Area with 17%, followed by Jableh Area with 15%, followed by Tartus Area with 11%, followed by Qardahah Area with 10%, followed by Haffa Area with 9%, followed by Shayk-Badr Area with 8%, followed by Safita Area with 7%, and finally Draykish Area with 3% (Fig. 2).

According to the aforementioned results, we suggest the following checklist for Cerambycidae in Syrian Coastal Region:

#### Subfamily Prioninae

1. *Aegosoma scabricorne* Scopoli, 1763
2. *Callergates gaillardoti* Chevrolat, 1854
3. *Prinobius myardi atropos* Chevrolat, 1854
4. *Mesoprionus lefebvrei* Marseul, 1856
5. *Prionus komiyai* Lorenc, 1999
6. *Rhaesus serricollis* Motschulsky, 1838

#### Subfamily Lepturinae

1. *Stictoleptura* (s. str.) *cordigera* Fuessly, 1775
2. *Vadonia unipunctata syricola* Holzschuh, 1993

#### Subfamily Spondylinae

1. *Arhopalus fesus* Mulsant, 1839
2. *Arhopalus syriacus* Reitter, 1895

#### Subfamily Cerambycinae

1. *Icosium tomentosum atticum* Ganglbauer, 1882
2. *Aromia moschata ambrosiaca* Steven, 1809
3. *Phymatodes* (*Paraphymatodes*) *fasciatus* Villers, 1789
4. *Cerambyx cerdo* Linnaeus, 1758
5. *Cerambyx dux* Faldermann, 1837
6. *Cerambyx nodulosus* Germar, 1817
7. *Cerambyx welensii* Küster, 1845
8. *Certallum ebulinum* Linnaeus, 1767
9. *Chlorophorus varius damascenus* Chevrolat, 1854
10. *Chlorophorus sartor* O.F. Müller, 1766
11. *Clytus rhamni* Germar, 1817

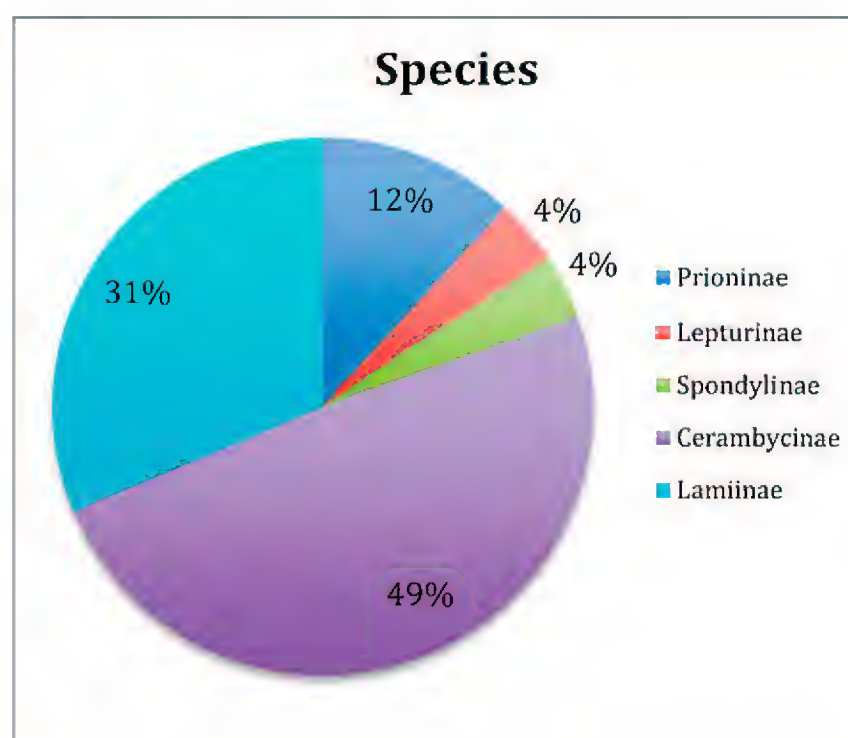


Figure 1. Taxa percentage among Cerambycidae subfamilies of Syrian Coastal Region.

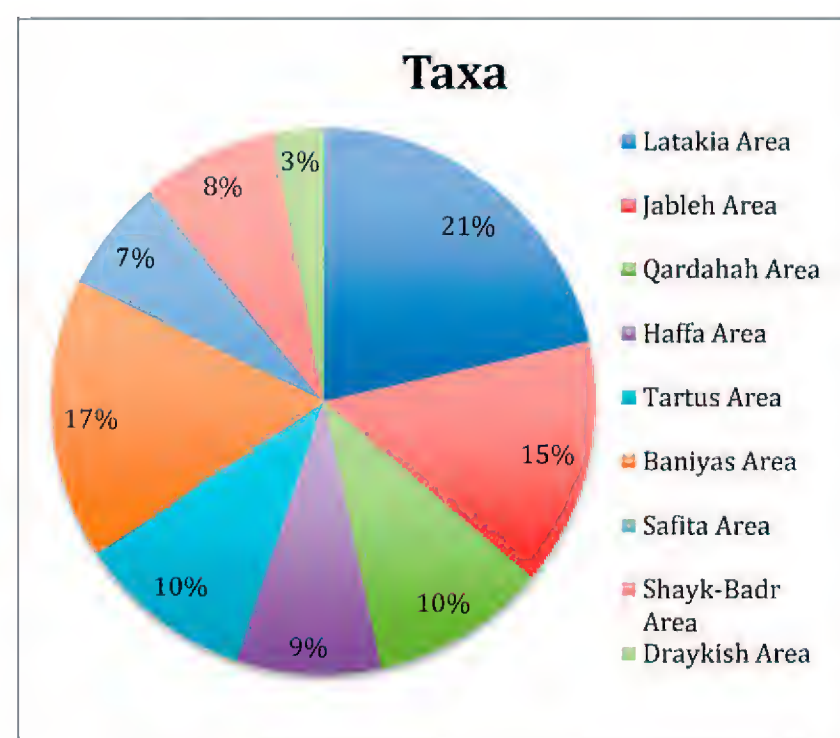


Figure 2. Percentage of taxa collected from the different area of Syrian Coastal Region.

12. *Plagionotus bobelayei* Brullé, 1832
13. *Xyloterchus* (s. str.) *stebbingi* Gahan, 1906
14. *Hesperophanes sericeus* Fabricius, 1787
15. *Stromatium unicolor* Olivier, 1795
16. *Trichoferus griseus* Fabricius, 1793
17. *Hylotrupes bajulus* Linnaeus, 1758
18. *Molorchus* (Caenoptera) *juglandis* Sama, 1982
19. *Phoracantha recurva* Newman, 1840
20. *Phoracantha semipunctata* Fabricius, 1775
21. *Purpuricenens budensis* Götz, 1783
22. *Purpuricenens dalmatinus* Sturm, 1843
23. *Lampropterus femoratus* Germar, 1824
24. *Stenopterus flavicornis* Küster, 1846
25. *Stenopterus rufus syriacus* Pic, 1892

#### Subfamily Lamiinae

1. *Acanthocinus griseus* Fabricius, 1793
2. *Leiopus* (s. str.) *syriacus* Ganglbauer, 1884
3. *Agapanthia* (s. str.) *lais* Reiche et Saulcy, 1858
4. *Agapanthia* (s. str.) *suturalis* Fabricius, 1787
5. *Agapanthia* (Epopetes) *coeruleipennis* Frivaldszky, 1878
6. *Agapanthia* (Epopetes) *pustulifera* Pic, 1905
7. *Calamobius filum* Rossi, 1790
8. *Batocera rufomaculata* DeGeer, 1775
9. *Monochamus galloprovincialis tauricola* Germar, 1818
10. *Oberea* (s. str.) *oculata* Linnaeus, 1758
11. *Phytoecia* (s. str.) *caerulea bethseba* Reiche et Saulcy, 1858
12. *Phytoecia* (s. str.) *rufipes latior* Pic, 1895
13. *Phytoecia* (Helladia) *alziari* Sama, 1992b
14. *Phytoecia* (Helladia) *humeralis humeralis* Walth, 1838
15. *Phytoecia* (Pilemia) *griseomaculata* Pic, 1891
16. *Niphona* (s. str.) *picticornis* Mulsant, 1839

Although the study area is relatively small (roughly 2.5% of the total area of the country), its diversity richness is rather obvious as the results indicate, and it is highly likely that more and further studies relating to Cerambycidae beetles will reveal new taxa and more data to the Syrian fauna of this family.

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## Germination of *Atriplex halimus* Linnaeus, 1753 (Caryophyllales Chenopodiaceae) in North West Algeria

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### ABSTRACT

In arid and semi-arid ambients, soil salinity is a constraint for the development of plants and a threat for balanced diet. Current data in the Mediterranean basin report up to 16 million hectares of salt soil, 3.2 million of which in Algeria. Germination in vitro of seeds of *Atriplex halimus* Linnaeus, 1753 (Caryophyllales Chenopodiaceae) in both synthetic media (nutrient agar, and Mueller Hinton) reached rates of 80% at 25 °C and 50% at 5 °C. The taxon shows a good resistance to salt; because of high salinity treatments (500 to 600 meq/l), there is a delay in germination but not complete inhibition of the process.

### KEY WORDS

*Atriplex halimus*; germination, salinity; North West Algeria.

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## INTRODUCTION

From the physiological point of view, germination is a process that translates the passage of the slow life of a seed to active life in the optimum conditions for germination. Several Authors (Côme, 1970; Mazliak, 1982; Suszka et al., 1994) divide the process of germination in two phases including:

- a first phase of entry of water into the seed (imbibition) which is accompanied by a resumption of intense metabolic activity;
- a second phase of turgidity of the seed which induces root elongation and therefore germination sensu stricto.

But all these steps occur only if certain intrinsic (conservation of the power of germination, lack of inhibition) and extrinsic (temperature, humidity, ventilation, and, sometimes, light) factors come together.

Given the importance of the germinal phase for the later stages of growth and development of any plant species, it is essential to study the germ beha-

avior under various environments conditions. If some works have addressed the germination process of *Atriplex halimus* Linnaeus, 1753 (Caryophyllales Chenopodiaceae) (Belkhodja & Bidai, 2004), however little work has been done on the rootlets in synthetic culture media. This has led us to approach throughout this work:

- Seed germination of *Atriplex halimus* in different culture media
- Germination of seeds of *Atriplex halimus* and salt stress.

## I. GERMINATION IN DIFFERENT CULTURE MEDIA

### *Material and methods*

As plant material used in this experimental work, we employed seeds of *Atriplex halimus* collected in the fields.

The laboratory equipment was composed of Boxes of Petri dishes, oven set at 25 °C and 35 °C, sterile forceps, bleach, 95% ethyl alcohol, nutrient agar flask, flask of Mueller Hinton, cotton wool, distilled water.

Each culture medium was prepared from a dehydrated medium (20 g/l), incorporated in one litre of distilled water; all being heated to boiling. The medium was then put in autoclaved bottles for 20 minutes at 120 °C (Table 1).

Disinfection of the plant material is always difficult and uncertain. The degree of infection of tissue on the surface is highly variable.

The method of disinfection of seeds was done according to the following protocol:

- washing under running water,
- immersion in a 80% solution of chlorine bleach for four minutes,
- rinsing with sterile distilled water for thirty seconds,
- soaking of seeds in 95% ethyl alcohol for ten seconds,
- three washes with sterile distilled water.

Then culture medium was liquefied by bath-marie and poured (in supercooling) in Petri dishes between two benzene becs.

The boxes were kept open to prevent the formation of water droplets on the cover. After disinfection, ten seeds were placed in Petri dishes by sterilized pliers. The boxes were then closed to avoid contamination.

All manipulations took place under hood (in sterile conditions). As controls, seeds were seeded on a cotton ball moistened with distilled water.

The number of repetition was six for each medium. The boxes were then placed at three different temperatures: 5 °C (refrigerator), 25 °C (room temperature) and 35 °C (oven) to test the effect of temperature on germination.

### Results and interpretations

Germinated seeds were counted per week regularly, taking as criteria of germination the envelopes pierced by the radicle; this allowed us to plot germination curves describing the course of germination, cumulative over time.

In our experience, we had a germination rate appreciable with a percentage of 80% (nutrient agar), 70% (distilled water and Mueller Hinton) at room temperature. But at cold temperature, ger-

Nutrient agar		Mueller Hinton	
Peptone	15 g	beef infusion solids	300 g
meat extract	2 g	casein hydrolysate	10.9 g
NaCl	5 g	Starch	1.5 g
Agar Agar	15 g	Agar	17 g
Distilled water	1000 ml	Distilled water	1000 ml
pH	7.6-7.8	pH	7.4

Table 1. Chemical composition of two culture media.

mination percentage was lower reaching 40% (for Mueller Hinton), 50% (agar), and 70% (in distilled water) (see Tables 2, 3; Figs. 1, 2).

## II. GERMINATION AND SALT STRESS

Halophytes develop naturally in strongly saline environments and their seeds do appear to express a certain tolerance to salt at the germination stage (Binet, 1988).

In Halophytes seeds germination in saline conditions is variable and species specific (Ungar, 1978).

We have undertaken this work to determine the critical response to germination of *Atriplex halimus* in a saline environment since its seeds have a great potential for germination.

### Material and methods

The Petri dish (es) used were sterile boxes of 19 cm in diameter and 3 cm thick. In each of the boxes, were placed ten seeds on cotton balls soaked in saline solutions at different concentrations. Each treatment included five boxes containing 10 seeds each. Petri dishes were kept with main parameters (temperature, photoperiod, humidity) helping to ensure a good environment relatively favourable to germination.

The seeds were selected based on size and health status. They were separated manually from fruit valves, then sterilized according to the following protocol:

- washing under running water,
- soaking in alcohol at 70% for 25 seconds,
- soaking in 80% bleach solution for 15 minutes,
- three washes with sterile distilled water, 10 minutes each.



	1 <sup>st</sup> week		2 <sup>nd</sup> week		3 <sup>rd</sup> week		4 <sup>th</sup> week	
	Number	%	Number	%	Number	%	Number	%
Distilled water	2	20	4	40	6	60	7	70
Nutrient agar	3	30	4	40	6	60	8	80
Mueller Hinton	2	20	3	30	5	50	7	70

Table 2. Number of *Atriplex halimus* seeds germinated at 25 °C.

	1 <sup>st</sup> week		2 <sup>nd</sup> week		3 <sup>rd</sup> week		4 <sup>th</sup> week	
	Number	%	Number	%	Number	%	Number	%
Distilled water	0	0	0	0	6	60	7	70
Nutrient agar	1	10	2	20	4	40	5	50
Mueller Hinton	0	0	1	10	2	20	4	40

Table 3. Number of *Atriplex halimus* seeds germinated at 5 °C.

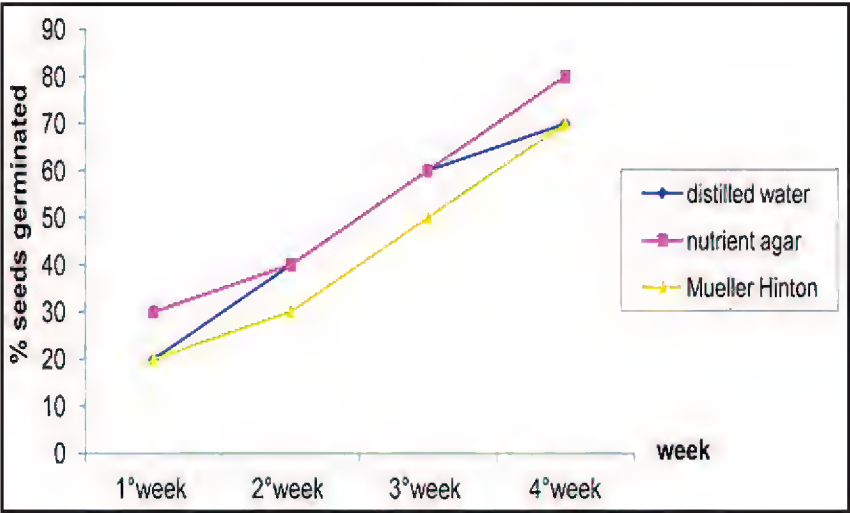


Figure 1. *Atriplex halimus* seed germination in various culture media at 25 °C.

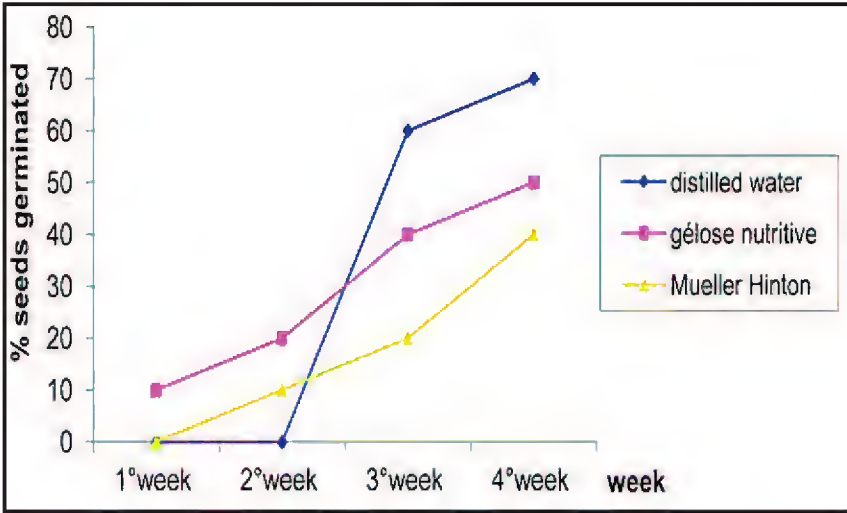


Figure 2. *Atriplex halimus* seed germination in various culture media at 5 °C.

By mixing equal volumes of two different salts: Sodium chloride (NaCl) and Calcium chloride (CaCl<sub>2</sub>) (VNaCl = VCaCl<sub>2</sub>), prepared in one litre of distilled water, we prepared six different concentrations (100, 200, 300, 400, 500, 600 meq.l<sup>-1</sup>). Distilled water was employed as control.

**Results and interpretations**

Tolerance of plants to salt stress varies at dif-

ferent stages of development (Rev & Freeman, 1976, 1976). Germination appears to be a stage of high sensitivity to salt stress (Zid & Boukhris, 1977). Seeds of *Atriplex halimus* have a great ability to germinate under high salinity conditions.

For treatments at 100 meq./l, 200 meq./l and 300 meq./l there is a respective decrease in germination of 10, 30 and about 40% compared with the control. For treatment at 400 meq./l, 500 meq./l and 600 meq./l, the germination was seriously affected,

ranging from 4 to 22% of germination rate. Germination occurred two days later for treatments at 300 meq./l, 400 meq./l and 500 meq./l, and four days later for treatment with solution at 600 meq./l

Therefore salinity of waters and soils not only results in inhibition of germination, but also in a very net delay of the process itself.

## DISCUSSION

Germination appears to be a stage of high sensitivity to salt stress (Zid & Boukhris, 1977). Changes in salinity degree strongly affect on germination,

growth and cellular anatomy of plants. Inhibition of germination of the seeds of *Atriplex halimus* is caused by the presence of high concentrations of sodium chloride. Stroconov (1964) confirms by his works that the response of seed to salinity is an indicator of tolerance of the plant.

Salinity can affect germination in two ways:

- decreasing the input speed of the amount of water absorbed by seed, the increase in the osmotic pressure of the water where the inhibition is too high.
- increasing the penetration of the ions that can accumulate in the seed at doses that become toxic

Riyad (1987).

*Atriplex halimus* support concentrations of

meq.l <sup>-1</sup>	100	200	300	400	500	600
NaCl (mM)	100	200	300	400	500	600
g/l	5.84	11.68	17.53	23.37	29.22	35.06
CaCl <sub>2</sub> (mM)	100	200	300	400	500	600
g/l	5.54	11.08	16.64	22.19	27.74	33.29

Table 4. Composition of saline solution.

Box Treatment	B1	B2	B3	B4	B5	average deviation	standard deviation
Witness	8	7	6	7	8	7.6	0.94
T1	6	5	7	7	6	6.2	0.83
T2	5	4	3	5	5	4.4	0.89
T3	3	3	2	4	4	3.2	0.83
T4	2	2	3	2	2	2.2	0.44
T5	1	1	1	0	1	0.8	0.20
T6	1	0	0	1	0	0.4	0.42

Table 5. Number of sprouts in different salinity conditions. B1-B5: Boxes or Petri dishes; Treatments: 100 meq/l (T1), 200 meq/l (T2), 300 meq/l (T3), 400 meq/l (T4), 500 meq/l (T5), 600 meq/l (T6).



Differences between averages	calculated t	Tests of significance
M1-M2	1.4	*
M1-M3	3.2	*
M1-M4	4.6	*
M1-M5	5.4	**
M1-M6	6.8	**
M1-M7	7.2	**
M2-M3	1.8	*
M2-M4	3.2	*
M2-M5	4	*
M2-M6	5.4	**
M2-M7	5.8	**
M3-M4	1.4	*
M3-M5	2.2	*
M3-M6	3.6	*
M3-M7	4	*
M4-M5	0.8	NS
M4-M6	2.2	*
M4-M7	2.76	*
M5-M6	1.4	*
M5-M7	1.8	*
M6-M7	0.4	NS

Table 6. Pairwise comparison between germination averages (M1–M7, in %); t = standard deviation.

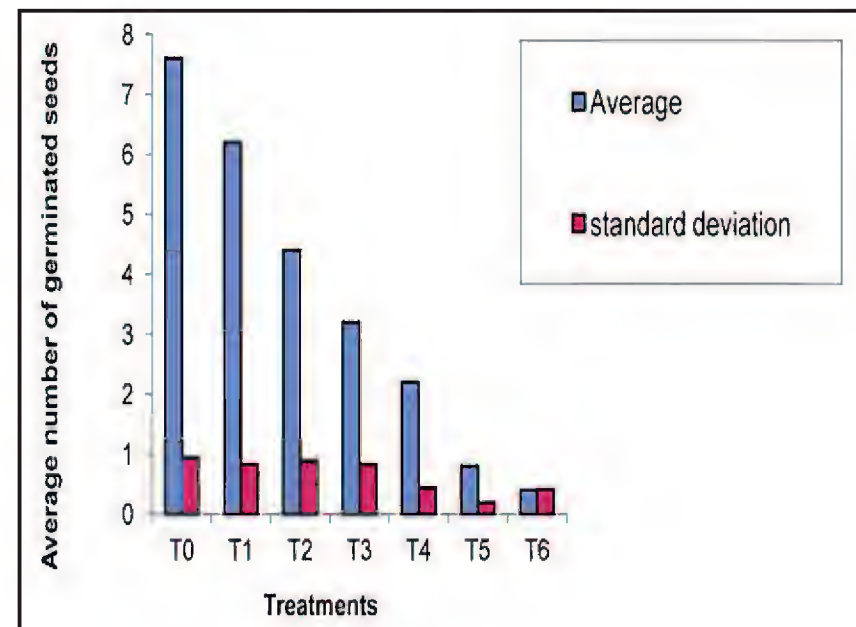


Figure 3. Average number of *Atriplex halimus* germinated seeds at different salinity conditions.

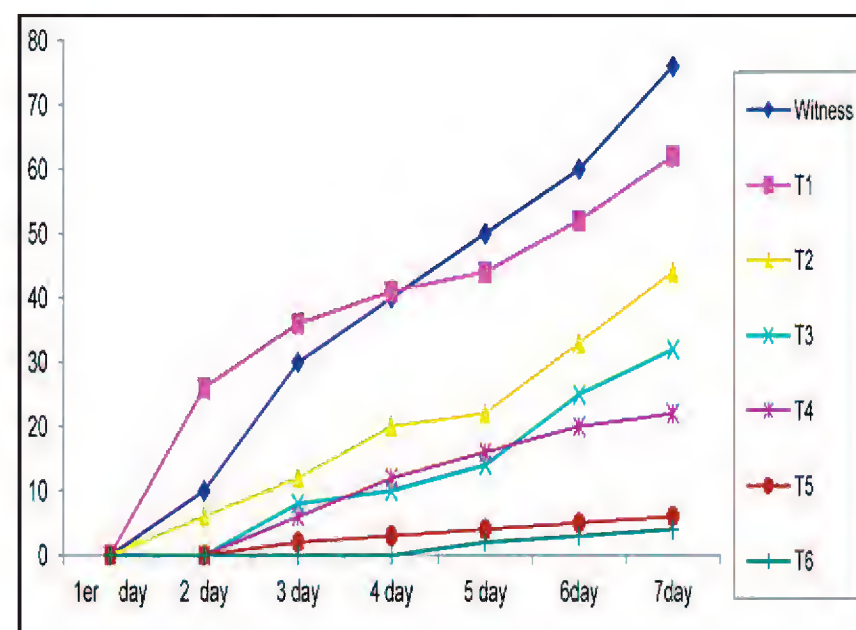


Figure 4. Percentages of germinated seeds at different salinity conditions.

Treatment Time germination	Witness	T1	T2	T3	T4	T5	T6
1 day	0	0	0	0	0	0	0
2 day	10	26	6	0	0	0	0
3 day	30	36	12	8	6	2	0
4 day	40	41	20	10	12	3	0
5 day	50	44	22	14	16	4	2
6 day	60	52	33	25	20	5	3
7 day	76	62	44	32	22	6	4

Table 7. Percentages of *Atriplex halimus* seed germination in different salinity conditions.

sodium chloride similar as that found in seawater (Ben Ahmed et al., 1996).

This is consistent with our results where the high salinity treatments at 500 meq./l and 600 meq./l, cause a delay in germination, but not a complete inhibition. It would be necessary much higher concentrations to really observe inhibition of germination of the seeds of *Atriplex halimus*.

Clemens et al. (1983) showed that at different saline concentrations there are differences in the germination rate of the seeds. These differences would likely come from the exogenous NaCl effect in general, which causes a reduction of the germination process.

The final stage of germination or inability of seeds to germinate seems to mean that with increasing salt concentration, the toxicity effect dominates due to the accumulation of sodium in the embryo by installing an osmotic inhibition (Guerrier, 1983; Bliss et al., 1986). Tolerance of *Atriplex halimus* to salt stress is often attributed to the presence of trichomes, on the surface of the leaves. The osmotic pressure of cell content is very high which is due to the massive mineral salts (sodium) accumulation or to the synthesis of large amount of organic substances.

## CONCLUSIONS

This study was carried out to highlight the germination capability of *Atriplex halimus* in various synthetic media. Germination in vitro in two synthetic media (nutrient agar and Mueller Hinton) and different temperatures (5 °C and 25 °C) shows that *Atriplex halimus* are characterised by a considerable germination rate.

According to our results, seeds seem to support a variable temperature range noting that cold induced retardation of germination, without however affecting the final germination percentage. *Atriplex halimus* has a resistance to saline stress, despite the observed delay, there was a germination rate that varies between 8 and 22% at a concentration of 600 meq./l. As already well underlined by

Belkhouja & Bidai (2004), our results confirm that confirm that *Atriplex* support high salinity conditions which allows to cultivate it on soils and waters generally considered unsuitable for agriculture.

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